CITY OF MANCHESTER.

Rivers Department.

ANNUAL REPORT

FOR THE

Year ending March 27th, 1929.

Price: Three Shillings and Sixpence.

Printed for the Manchester Corporation by
HENRY BLACKLOCK & CO. LIMITED, MANCHESTER,
and may be purchased either directly or through any Bookseller from
P. S. KING & SON, LIMITED,
Orchard House, Victoria Street, Westminster, London, S.W.

City of Manchester.

RIVERS DEPARTMENT.

Annual Report

FOR THE

YEAR ENDING MARCH 27th, 1929.

Rivers Department,
Ship Canal House,
King Street,
Manchester.

MEMBERS OF THE RIVERS COMMITTEE,

1928-1929.

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DEPUTY-CHAIRMAN—Councillor John Elliott, J.P.

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(The Right Honourable George Westcott, J.P.).

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CITY OF MANCHESTER.

Rivers Department.

Annual Report for the Year ending March 27th, 1929.

The Rivers Committee submit to the Council the following report on the work of the Rivers Department :—

Introductory.

The duties of the Rivers Committee are defined in the Council's Instructions to Committees, as follows :—

" To enforce and carry out the provisions of any public or local Act, or any legal remedy with respect to the rivers, brooks, or streams, wholly or partially within the City, and with respect to all other matters connected therewith ;

" That the said Committee be authorised and instructed to carry out and complete the Manchester Main Drainage Scheme, including all works in relation thereto, and for those purposes to exercise the powers of the Corporation under the Public Health Acts ;

" Also to execute the powers and duties of the Council with respect to the Sewage Outfall and Main Drainage Works of the Corporation under paragraph 2 (2) of the Fifth Schedule of the Manchester Corporation (General Powers) Act, 1904 (Chorlton-cum-Hardy Sewage Works to be used only for the three Withington Wards and the Urban District of Levenshulme as then defined) ; Part IV. (Sewerage) of the Manchester Corporation Act, 1908 ; Part V. (Sewerage) of the Manchester Corporation Act, 1909 ; Part IV. (Main Drainage Works) (except section 50) of the Manchester Corporation Act, 1911 ; Part VI. (Sewerage) of the Manchester Corporation Act, 1920 ; Part VIII. (Main Drainage) of the Manchester Corporation Act, 1924 ; and under any other local enactment ; also the provisions as to the discharge of certain matters into sewers, contained in section 21 of the Manchester Corporation (General Powers) Act, 1902, and the orders thereunder ; also to carry out and enforce the provision enabling the Corporation to define the boundaries of rivers, brooks, and watercourses contained in section 55 of the Manchester Corporation Act, 1911 ;

" Also to carry out the powers and duties of the Council under the following portions of the Manchester Corporation Act, 1914, viz. :—Part VI. (Main Drainage Works) and the following sections of Part VIII. (Miscellaneous), viz. :—Sections 48 (Maintenance and repair of banks of River Mersey), 50 (Watercourses not to be

covered in except in accordance with approved plan), 51 (Chemical refuse, steam, etc., not to be turned into culverted watercourse), 52 (Owners to repair and cleanse culverts), 53 (Corporation may define levels of rivers, brooks, and watercourses), 54 (Removal of weirs), 55 (Exemption of Canals), 71 (For protection of the Stretford Gas Company), 72 (2) (For protection of the Cheshire Lines Committee), 73 (For further protection of the Trafford Power Company), Sub-sections (16), (18), and (19) of section 74 (For protection of Manchester Ship Canal Company), and Section 76 (For protection of Lord Egerton's Trustees) ;

" Also to direct and manage the powers, authorities, and duties of the Council under the Rivers Pollution Prevention Acts, 1876 and 1893, section 14 of the Local Government Act, 1888, and sections 16, 17, and 47 of the Public Health Acts Amendment Act, 1890 ;

" Also to carry out and enforce the following provisions contained in the Public Health Act, 1925 :—

Section 40 (Power to require specially enlarged sewer in new street). (In common with the Paving, Sewering, and Highways Committee and the Improvement and Buildings Committee.)

Section 41 (Prevention of entry of petrol, etc., into sewer). (In common with the Public Health Committee and the Paving, Sewering, and Highways Committee.)

Section 51 (Power to require the covering in of watercourses and ditches). (In common with the Paving, Sewering, and Highways Committee and the Improvement and Buildings Committee.)

Sections 54 (Watercourse choked up to be a nuisance under the Public Health Act, 1875), and 55 (Power of local authority to defray cost of or execute works). (In common with the Paving, Sewering, and Highways Committee and the Public Health Committee) ;

" And that the said Committee shall have, and this Council hereby delegate to the said Committee, all and every the powers, authorities, and discretion which, by the said Acts, in relation to the matters and purposes aforesaid, are now given to, or vested in, this Council ;

" And the said Committee are hereby authorised to carry out the instructions heretofore given to the Rivers Committee, or which may, from time to time, be given to the said Committee by this Council."

The total length of sewers constructed and completed to date is 26·67 miles, viz. :—Manchester Main Drainage Scheme 23·60 miles, under the Manchester Corporation Act, 1908, 0·93 miles, and to the relief of flooding in Moss Side and Whalley Range 2·14 miles, of which 4·50 miles were executed by the Committee's staff without the intervention of a contractor.

The sewers vary in size from 2·25 ft. to 15·25 ft. in diameter. They are constructed with red engineering bricks and shale bricks set in cement mortar. No surface clay bricks have been used.

Owing to the presence of water in the subsoil, considerable lengths of sewer have had to be executed under air pressure. The completed sewers pass beneath the London, Midland, and Scottish, the London and North Eastern, the Manchester, South Junction, and Altrincham, and the Cheshire Lines Committee Railways in seventeen places, and cross the Bridgewater Canal in seven places.

The Rivers Committee control the admission of all trade effluents into the sewers, according to the provisions of the before-mentioned Acts, and a special Inspector has charge of this work.

The main activity of the Committee is, however, connected with the disposal of the City sewage.

With the exception of the sewage from the Withington district, which receives treatment at the Withington Works, Chorlton-cum-Hardy, the whole of the City sewage is dealt with at the main outfall works at Davyhulme.

In addition, the sewage from the Borough of Middleton and from the area governed by the Barton Rural District Council, together with some portions of the sewage from the Audenshaw and Stretford areas, also passes to the Davyhulme Works. A portion of the old Moss Side Works at Urmston is still retained for the treatment of storm-water only, and the Middleton Sewage Works have been reconstructed to provide for the treatment of a certain proportion of the storm-water from this district.

The following statements show in summarised form the details of the Committee's expenditure for the year under review :—

The total charge on the rates in respect of the work of the Committee was £228,653 17s. 8d.

Of this amount, a sum of £56,188 18s. 1d. was required for the upkeep of the Davyhulme, Withington, Moss Side, Middleton, and Gorton Sewage Works, and for general rivers work, comprising the administration at the Town Hall, the cost of labour and various rivers improvements, contribution to the Mersey and Irwell Joint Committee, etc.

The remainder, amounting to £172,464 19s. 7d., was applied in the payment of interest on loans and repayment of debt on the capital outlay on intercepting sewers throughout the whole of the City, and on the purification plant at the various sewage works.

The details are as follow :—

Administration and Upkeep.

	£ s. d.	£ s. d.
Davyhulme Sewage Works ..	*42,055 1 11	
Withington	6,789 11 7	
Moss Side	136 8 8	
Gorton	365 13 11	
Middleton	344 8 8	
Rivers Account	5,455 4 8	
Main Drainage Scheme (1911) ..	1,042 8 8	
		56,188 18 1

Interest on Loans and Repayment of Debt.

Manchester	†70,528 4 1	
Withington	7,125 11 1	
Moss Side	51 14 4	
Gorton	804 12 8	
Rivers Account	492 0 10	
Main Drainage Scheme (1911) ..	93,462 16 7	
		172,464 19 7
Total		£228,653 17 8

* This amount represents the net cost to Manchester after deducting contributions from Audenshaw, Stretford, Barton, and Middleton Authorities (see Table IV. footnote).

† Included in this figure is a sum of £31,000 (approximately), the annual charge on the capital outlay on the Manchester Sewers (apart from the Main Drainage Scheme, 1911), amounting to £627,091, and certain payments in respect of the Middleton Sewage Works.

Wild Birds' Protection.

It is regretted that the endeavours of the Rivers Committee to obtain an extension of the powers conferred by the Wild Birds' Protection (City of Manchester) Order, 1925, so as to include and cover the various properties of the Department situated outside the City boundary have only been partly successful. The Cheshire County Council are of opinion that no adequate reason has been shown to justify the imposition of special restrictions in regard to wild birds on the Rivers Department's lands at Carrington, and they are therefore not prepared to recommend an amendment of their existing Order. The Middleton Town Council consider that the site of the old Middleton Sewage Works (now the property of Manchester) at Rhodes is too small and otherwise unsuitable for inclusion in an Order. The Lancashire County Council have agreed to make application to the Home Secretary to amend their Order of 1926, so as to include and cover the Department's Sewage Works and adjoining lands in the Urban Districts of Davyhulme, Flixton, and Urmston. House sparrows, rooks, greenfinches, magpies, wood pigeons, little owls, and sparrowhawks are exempted from protection, as these birds are considered to be detrimental to farming interests.

Works to Relieve Unemployment.

In order to assist in the relief of unemployment, a scheme of co-operation between the Corporation and the Manchester Board of Guardians was adopted early in 1928, whereby men receiving outdoor relief from the Guardians could be employed by the Corporation upon useful relief work. Wages for this work were paid to the men in accordance with the prevailing rates in the municipal service, and the Corporation received from the Guardians sums equivalent to the amounts the men would have received in outdoor relief had they not been employed under the joint scheme.

The relief works undertaken by the Rivers Department consisted of (*a*) the repair and consolidation of the banks of the River Mersey on the Committee's property at Carrington, Flixton, and Chorlton-cum-Hardy ; (*b*) the construction of a protective earthen bank and a range of sludge lagoons at the Middleton Sewage Works, Rhodes ; and (*c*) the raising and strengthening of the earthen bank of the River Mersey overflow channel at the Moss Side Sewage Works, Newcroft Meadows, Urmston. All these were considered useful works of flood prevention which would not have been proceeded with apart from the pressing need for relieving unemployment. The estimated cost of the relief works was £2,000, and the actual costs are given in Tables II., III., and IV.

Central Electricity Board.

Preliminary surveys have been carried out during the year by representatives of the Central Electricity Board over the Committee's lands at Davyhulme and Flixton, with the object of finding the most suitable track along which to carry a high voltage overhead transmission line passing from Carlisle to Liverpool, as part of the Central Electricity Board's "North-West England and North Wales Electricity Scheme, 1928."

As the plans produced to the Department disclosed the fact that the transmission line would be carried on lofty lattice-work towers across the Davyhulme Sewage Works, and that a large area of the Committee's land at Carrington, hitherto intended for sludge disposal purposes, would be required for the erection of a new power station, the Committee are obtaining from the Town Clerk a report on the powers of the Central Electricity Board and their relation to the policy of the Committee.

Visit to Germany.

During the year a deputation consisting of Councillors Hutchinson and Robinson, and the Consulting Chemist, visited Germany to study the latest developments in sludge disposal, with particular reference to the problem of secondary digestion of sewage sludge, with or without recovery of the gaseous products. A special report on the visit was presented to the City Council on the 6th February, 1929. Visits were paid to the Emschergenossenschaft and the Ruhrverband, two great authorities which have the surveillance and control of the sewage disposal of their respective districts. Sewage Works were inspected at Essen Frohnhausen, Essen Nord, Rellinghausen, Velbert, Verden, Gelsenkirchen, Bochum, Schwerin, Holzwickede, Berlin, Dresden, Munich, Stuttgart, and Cologne, together with the Emscher River Treatment Works near Karnap. It was found that secondary digestion with recovery and utilization of the gaseous products of fermentation is being almost invariably adopted throughout Germany as the best and most economic means of disposing of sewage sludge. From the works they saw in actual operation, the deputation were convinced of the practical character of this method of sludge disposal, and it appears probable that it can be advantageously applied in Manchester. A Special Sub-Committee of the Rivers Committee is at present considering the matter.

MAINTENANCE OF RIVERS AND STREAMS.

The work of the river men has been distributed as follows :—

River Medlock.

	Days worked
Between Pin Mill Weir and Fairfield Street	35
,, Fairfield Street and Mayfield Tunnel	43
,, Mayfield Tunnel and Jackson Street	42
,, Westhead's Weir and Charles Street	30
,, Charles Street and Birley's Weir	23

Cornbrook.

Between Bennett Street and Gardner Street	8

Nico Ditch, Crowcroft Brook, Gore Brook, Didsbury Drainage Ditch, etc.	8

Posting warning notices *re* solid refuse cast into streams	5

Green Lane Depot.

Repairing waders and tackle, limewashing, etc.	31

Westhead's Weir.

Attending sluices during floods	23
Drawing weir at week-ends and impounding water ..	18
Repairs	22
Removing accumulations and cleaning	22

Birley's Weir.

Removing obstructions	2

Assisting Rivers Inspector during examinations of streams, sampling sewers and trade effluents ..	269

Manchester Corporation Acts, 1869, 1882, etc.

Twenty-nine cases of infringement of the above Acts, which consist principally of the casting of refuse into streams, the placing of obstructions in waterways, and the tipping of refuse on river banks, have been dealt with.

Compliance with the requirements of the Corporation has usually been obtained without much difficulty, but where resort to legal notice became necessary, the work required was carried out by the Corporation at the expense of the offenders.

Trade Refuse in Sewers.

Numerous examinations of the effluents from manufactories connected to the sewers have been made, and many samples have been submitted to the technical staff of the Department for analysis. Complaints have been necessary from time to time with regard to acid effluents and the presence of excessive suspended solids, etc.

In several cases of boiler discharges into sewers, owners have been served with notice of the provisions of the Public Health Acts Amendment Act, 1890, section 17.

In December, 1928, a fire occurred in a sewer in the Bradford District. No damage was done, but the outcome would have been serious had not a man who was working in the sewer withdrawn a few minutes before the event.

The cause of the fire was not positively established, but the evidence obtained indicated that it was almost certainly due to the discharge into the sewer from a neighbouring works of residues containing carbon bisulphide.

In order that the Corporation might be in a position to take legal action in case of future discharges of this nature the City Council made an Order under its powers conferred by the Manchester Corporation Act, 1902, prohibiting the discharge of carbon bisulphide into the city sewers.

The Order is in the following terms :—

The Lord Mayor, Aldermen, and Citizens of the City of Manchester do hereby in pursuance of the powers contained in the Manchester Corporation (General Powers) Act, 1902, declare that they are of opinion that the introduction of manufacturing or trade refuse containing carbon bisulphide into a sewer, whether alone or in combination with other matter or liquid, and whether directly or through any drain or channel communicating therewith, involves danger to the health of persons entering the sewers or others, and the said Lord Mayor, Aldermen, and Citizens do hereby in pursuance of the powers aforesaid by this their Order absolutely prohibit from the expiration of fourteen days after the service of this Order any such matters as aforesaid being caused or permitted to fall, flow, or enter, or to be carried or washed into any sewer either directly or indirectly.

As witness the Corporate Common Seal of the Lord Mayor, Aldermen, and Citizens of the City of Manchester this 25th day of March, 1929.

Similar Orders have already been made by the City Council for the exclusion from the sewers of sulphides and poly-sulphides, and of petrol and allied spirits.

Floods.

No floods of any importance have been registered during the year.

During the year plans have been submitted to the Rivers Committee for the following, viz. :—

River Irk	Bridge over stream near Hendham Vale.
	Encroachment on river line at Blackley.
	Diversion of stream at Rhodes (Middleton).
	Projection into stream at Crumpsall.
Ball Brook	Culverting at Fog Lane, Didsbury.
	Culverting at Kingsway, Didsbury.
Nico Ditch	Culverting at Gorton.

The diversion at Rhodes brings a new and improved length of the River Irk into the City.

THE TREATMENT OF SEWAGE AT THE WITHINGTON WORKS.

Description of Works.

These works came under the control of the Rivers Committee upon the inclusion of the Withington Urban District Council District within the City on November 9th, 1904. They are situate at Chorlton-cum-Hardy, at the extreme western corner of the district, and are bounded by the River Mersey on two sides—south and west—the Chorlton Brook on the north, and an embankment on the east.

These works were originally designed to purify the sewage by treatment on the land. Subsequently a sedimentation tank and double-contact filter plant was installed as follows :—Two detritus tanks (capacity 83,400 gallons), two sedimentation tanks (capacity 781,000 gallons), ten first contact beds (2,900 superficial yards each), ten second contact beds (2,900 superficial yards each), and an area of storm beds of 12,452 superficial yards divided into four plots measuring respectively 2,882, 3,533, 3,751, and 2,286 superficial yards. A conical catch-pit in connection with the high-level sewer was constructed later (*see* report for the year ending March, 1911). In 1914 two Emscher (double-decked) tanks were constructed of sufficient capacity to deal with from 600,000 to 700,000 gallons per day, a general description of which appeared in the report for the year ending March, 1915.

A continuous-flow unit for the treatment of the sewage by the activated-sludge process was brought into operation in October, 1917, and occupies one-third of one of the above-mentioned sedimentation tanks. A complete account of this plant, together with plan, was given in the Annual Report for the year ending March, 1918.

An additional larger activated-sludge unit was brought into commission in August, 1923, and occupies one-third of one of the original second contact beds. A complete description of this installation was given in Appendix I. to the report for the year ending March, 1924 ; a plan of the same appeared in the Annual Report for the year ending March, 1923.

A general plan showing the arrangement of the present works appeared in the Annual Report for the year ending March, 1923.

The land is practically level throughout; consequently it was found necessary, in order to carry out the scheme of double-contact beds, to raise the sewage at the outfall works, and, in order to avoid pumping the whole, to arrange the new outfall main sewers to gravitate the sewage of the upper zone of the district and the whole of the Levenshulme sewage, leaving only that from Didsbury and Chorlton-cum-Hardy to be pumped.

With the River Mersey and Chorlton Brook at ordinary level, the effluent is passed into the latter at a point some 300 yards above its junction with the Mersey; but when the river and brook are in flood it is passed by a syphon under the Chorlton Brook into the Ousel Brook at a point near the Stretford Cemetery, and about half a mile below the Sewage Works. In addition to this, there is a storm-water reservoir nine acres in area for impounding storm water from the Chorlton-cum-Hardy district, as well as a portion of the effluent from the works. When the River Mersey is about its normal level this storm-water reservoir is discharged by gravitation into the river; but should the river be in flood, it is then pumped by means of a suction-gas pumping installation.

In connection with the present main drainage scheme, arrangements have been made whereby the sewage from Levenshulme and Mauldeth Road can be diverted either to the Withington Works or into the main City outfall.

Since 29th November, 1928, approximately 750,000 gallons per day have been diverted to the Davyhulme Works.

The total population at present connected with the works is *76,200, viz., Withington 51,300, and Levenshulme 24,900.

The average daily flow of sewage (including storm water) for the year under observation amounted to 3,927,000 gallons, or 52 gallons per head of population per day.

With the exception of the suction gas plant referred to above, the whole of the power used on the works is now derived from the Corporation Electrical Supply.

The plant in the engine room comprises four centrifugal pumps for lifting the low-level sewage, air compressor for delivering the sludge through mains on to the land, and air compressors for the operation of the activated-sludge installations, all driven from electric motors of from 15 to 60 H.P.

In addition, there are small motors attached to screens placed on high and low level sewers, and for driving chopping machine.

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* No adjustment has been made for the diversion of a portion of the sewage flow to Davyhulme.

Area of Land.

The total area of land comprising the Withington Sewage Works amounts to 92·5 acres, and is divided up as follows :—

	Acres.
Land occupied by detritus, sedimentation, and activated-sludge tanks	2·25
Land occupied by buildings and sludge tank	
Land occupied by lay-byes and storage	
Land occupied by storm-water reservoir	9
Land occupied by bacteria beds	11·75
Land occupied by storm-water filters	2·5
Total area of land occupied	25·5
The area of land not occupied by bacteria beds, storm-water filters, buildings, tanks, etc., but under cultivation	67·0
Grand total	92·5

Of the land not utilised for sewage treatment an area of 21½ acres has again been let for a portion of the year as grazing land, an income of £69 17s. 6d. having been received.

River Mersey Banks.

There have been no serious disturbances of the River Mersey banks bounding these works during the past year, and in the ordinary way little expenditure would have been incurred on their maintenance.

In order, however, to provide useful work for some of the unemployed, the banks have been consolidated and improved in certain places. The cost of this work is given in Table II.

Volume of Sewage Treated.

The volume of sewage actually delivered at these works is estimated at 1,429,485,000 gallons, an average of 3,927,000 gallons per day. The details of the flow, together with the volume in terms of per head of population and rainfall records, are given in the following table :—

Sewage Flows.

Period of 4 weeks ending	Total Flow.	Average Daily Flow.	Average Daily Flow.	Rainfall.
	Gallons.	Gallons.	Gallons per head.	Inches.
1928				
April 25th	112,102,000	4,004,000		1·64
May 23rd	101,304,000	3,618,000		1·41
June 20th	111,045,000	3,966,000		3·12
July 18th	123,711,000	4,418,000		2·78
August 15th	104,892,000	3,746,000		2·30
September 12th.....	124,131,000	4,433,000		3·42
October 10th.....	106,362,000	3,799,000		1·89
November 7th	123,533,000	4,412,000		2·14
December 5th	160,851,000	5,745,000		3·92
1929				
January 2nd	100,437,000	3,587,000		1·84
January 30th.....	89,566,000	3,199,000		1·39
February 27th	90,761,000	3,241,000		0·98
March 27th	80,790,000	2,885,000		0·78
Total for 52 weeks...	1,429,485,000	3,927,000	52	27·61
Total for 52 weeks ending Mar. 28th, 1928	1,720,483,000	4,726,000	63	37·97

A measurable rainfall occurred on 170 days, as compared with 211 days during the previous year.

Sludge Disposal.

In the following table is given the amount of sludge removed during the year from the various tanks :—

	Tons
Screening, etc.	370
Conical Tank	550
Detritus Tanks, Sedimentation Tanks, and Activated-sludge Tanks	22,020
Emscher Tanks	460
Total	23,400

The total amount of sludge produced, viz., 23,400 tons, is equal to 16.4 tons per million gallons.

The sludge from the detritus, sedimentation tanks, and activated-sludge tanks has been trenched into the land as usual.

Emscher Tanks.

A general description, together with plan, of these tanks was given in the Report for the year ending March, 1915.

The tanks have been in continuous operation throughout the year and have dealt with 259,275,000 gallons of sewage, an average of 712,000 gallons per day, as compared with a daily flow of 770,000 gallons during the preceding year.

A total of 460 tons of sludge was discharged from the tanks on to the drainage beds provided. The air-dried sludge has been used on the land under cultivation.

A small portion of the gas resulting from the digestion of sludge in these tanks is now piped to the laboratory where, since January of this year, it has displaced methylated spirits formerly used for heating purposes.

Filtration of Effluent from Sedimentation and Emscher Tanks.

Of the total flow of 1,429,485,000 gallons of sewage received at the works, 454,905,000 gallons were treated by the activated-sludge process, and the remainder, viz., 974,580,000 gallons, was dealt with on the filtration areas.

The storm beds dealt with a total volume of 107,593,000 gallons, which is equal to 118,000 gallons per acre per day. The primary and secondary beds dealt with a total volume of 866,987,000 gallons, which means that on the average (including all periods of rest), tank effluent was applied to the primary beds at the rate of 397,000 gallons per acre per day.

The work on the surface of the filter beds in connection with the removal of accumulated sludge and of heavy growths of weeds, etc., has proceeded as usual, the cost of which for the various filtration areas is given in Table II.

Treatment of Sewage by the Activated-sludge Process.

Purification plant in operation for the treatment of sewage by the activated-sludge process—diffused aeration system—consists of (i.) a small continuous-flow unit installed in 1917, and described with plan in the Annual Report for the year ending March, 1918, and (ii.) a large-scale continuous-flow unit installed in 1923 and modified in 1926. A description of the large-scale unit as originally installed is given with plan in the Annual Report of 1923 ; the modifications of 1926 are referred to in the Annual Report of 1927, page 16.

The air-compressing plant comprises two reciprocating compressors, driven by 27 and 30 H.P. electric motors respectively, each capable of compressing approximately 700 cubic feet of free air per minute, and a special type compressor (installed in 1924), driven by a 25 H.P. electric motor, capable of compressing 400 cubic feet of free air per minute. One of the larger compressors is used as a stand-by.

The normal working pressure is 4lbs. per square inch.

Each purification unit is provided with meters, etc., for recording the volume of sewage treated and the volume of air used. A meter is also provided for the measurement of the electrical units consumed.

Prior to passing to the aeration tanks the sewage is screened and freed from the coarser suspended solids by passage through detritus tanks having a capacity equivalent to 40 mins. D.W.F.

During the past year the two units have been in continuous operation, and a total volume of 454,905,000 gallons of screened and detritus-free sewage has been treated, which represents approximately 32 per cent. of the total volume of sewage received at the works.

Details of operation, with average analytical returns, are as follows :—

Activated-Sludge Process—Withington Works.

	Small unit	Large unit
Total volume of sewage treated	110,965,000 gallons	343,940,000 gallons
Volume of sewage treated per day (average)	305,000 ,,	945,000 ,,
Air consumption :—Free air per gallon of sewage treated..	1·39 cub. ft.	1·26 cub. ft.
Average detention period (aeration tank)	4·8 hours	6·5 hours

Analytical Returns—Results in grains per gallon.

	Screened and detritus-free sewage	Effluents	
		Small unit	Large unit
Four hours oxygen absorption	3·00	·50	·53
Three minutes oxygen absorption :—			
Before incubation	1·08	·20	·22
After incubation	—	·17	·20
Putrescibility	—	15/249	$36\frac{1}{2}$/248
Free and saline ammonia	2·14	2·03	2·05
Albuminoid ammonia	·67	·145	·16
Nitrite (in terms of NH_3)	—	trace	trace
Nitrate (in terms of NH_3)	—	·07	·06
Biochemical oxygen demand (†Royal Commission Test)	—	1·02	1·09
Suspended solids	13·2	·85	·94

† Standard recommended not more than 1·40.

Remarks.

The volumes of sewage treated by these units are less than those recorded for some years past, and the air consumption per gallon of sewage treated shows an appreciable increase, as might be expected from the substantial increase in the average strength of the sewage treated, consequent on the exceptionally low rainfall during the last quarter of the year.

Having regard to all the factors obtaining in this abnormal year, the results obtained compare favourably with those yielded formerly.

Throughout the year no difficulty has arisen in respect of sludge control.

The renewal of the stones of the diffusers of these units, after being in use for 5 to 6 years, was commenced in May, 1928. At the end of the year the renewals in the small unit had been completed and the renewal of the stones in the large unit was in progress.

A small centrifugal pump, for the removal of surplus sludge from the sludge chamber of the large unit to several points on the works for further treatment or as required, was installed in January.

MOSS SIDE SEWAGE WORKS.

The storm-water overflow at these works came into operation on 79 occasions during the year ; the average depth measured over a 6ft. sill was $9\frac{3}{4}$ inches.

The total amount of semi-dried sludge removed from the storm-water lagoons was 126 cubic yards.

The maintenance costs are given in Table III.

GORTON SEWAGE WORKS.

As previously reported these works are no longer in commission for the treatment either of sewage or storm-water, but the Department have been unable to dispose of the property. The charges on these works are given in Table III.

MIDDLETON SEWAGE WORKS.

During the year, three sludge drying beds were made for dealing with the sludge removed from the storm-water now treated at these works. This work was done by labour provided through the Manchester Labour Exchange, and partly financed by the Board of Guardians.

The total amount of semi-dried sludge removed from these sludge drying plots was approximately 50 cubic yards.

Owing to the frequent use of the storm-water overflows to these works, an attendant paid regular visits to ensure proper attention.

The expenditure incurred during the year in itemised in Table III.

THE TREATMENT OF SEWAGE AT DAVYHULME.

Description of Works.

The original works, which came into operation early in 1894, were designed for the treatment of the sewage by chemical precipitation.

The new works for bacterial treatment of the sewage were completed in 1904 so far as to permit at that date of the whole of the dry-weather flow being dealt with in tanks and primary contact beds.

A general plan showing the arrangement of the existing works appeared in the Annual Report for the year ending March, 1923.

The sewage, as it reaches the works, passes through a system of screens and catch-pits, designed to intercept coarser floating matter and heavy detritus.

Subsequently the sewage passes through either sedimentation or open septic tanks, and, at the present time, that portion of the tank effluent not treated on the existing contact beds passes direct to the Ship Canal.

The sludge removed by tank treatment of the sewage is discharged, either by gravity or pushed by manual labour, into subway channels leading to two ejectors, from which the majority of the sludge is forced under air pressure into three storage tanks near the banks of the Ship Canal below Barton Locks. The sludge is removed from these tanks by (*a*) gravity flow to the sludge steamer, and subsequently is deposited at sea beyond the Mersey Bar, and (*b*) pumping through the sludge main for disposal on land at Flixton and Carrington.

If required, a small proportion of the sludge may be dewatered in plate presses, and the resultant cake disposed of as a manure, either with or without subsequent drying in a rotary drying plant.

A complete description of the scheme originally sanctioned by the Local Government Board is given in the report, entitled "Treatment of Manchester Sewage," issued in July, 1902, where the details of construction of the primary contact beds and storm-water beds may be found.

Subsequently permission was granted by the Board to construct the secondary beds at Bent Lanes, adjacent to the original works, instead of at Carrington and Flixton.

A general description of the construction of the secondary beds is given in the Annual Report for the year ending March, 1909.

Extensions of Works.

As stated in previous reports, a scheme for the extension of the existing purification plant was approved by the Ministry of Health in September, 1925, which provides, *inter alia*, for the construction of additional detritus tanks and new screening chamber, activated-sludge units to deal with a minimum of one-half the dry weather flow of sewage, together with the proportion of storm-water requiring full treatment, and the provision of a sludge main from the Davyhulme Works to land owned by the Corporation at Flixton and Carrington.

The completed parts of the above scheme commence at a point near the entrance gates to the Works, where the existing 10ft. diameter and 13ft. diameter sewers are joined, and continued in an open channel 17ft. wide. Along this channel, which is constructed of concrete and lined with engineering bricks, the sewage is conveyed to the detritus tanks. About 80ft. down-stream from the commencement of this channel an overflow cill, 50ft. long, has been constructed to take the storm-water, and the amount passing over this cill is regulated by an automatic penstock, which, when the scheme is completed, will be lowered from cill level during the day to 18in. above invert at 10 p.m., passing sewage for full treatment up to the rate of 48,000,000 gallons per 24 hours, and resuming cill level at 10 a.m. to pass sewage to a maximum rate of 80,000,000 gallons per 24 hours.

Six new detritus tanks (illustrated in photographs Nos. 1, 2, and 3) have been provided for removing the heavier suspended matter from the sewage, these tanks are 120ft. long, 16ft. wide, 12ft. deep at the inlet end, and 12ft. 6in. deep at the outlet end below the channel level, the sides and bottom of the tanks being rounded off to a 5ft. radius, giving a capacity for each tank of 139,000 gallons. The tanks are constructed of concrete lined with engineering bricks above the invert level of the inlet channel, and with Staffordshire blue bricks below. Penstocks are fixed at each end of the tanks so that any one tank can be thrown out of service for the removal of detritus.

The detritus is removed by a grabbing crane which may travel along three of the reinforced concrete roads between the tanks, and is loaded into wagons carried on the remaining two intermediately situated divisional walls.

From the detritus tanks the sewage passes to the screening chamber, which is 84ft. long, 65ft. wide, and 20ft. high. This building contains four travelling rope band screens, each 41ft. long with an effective width of 8ft. (see photograph No. 4). Each screen has four galvanised

steelwire ropes, $\frac{3}{16}$in. in diameter, which passing over pulleys form 55 turns in each rope, giving $\frac{1}{4}$in. clearance, and making a total of 220 turns for each screen. The slowest speed which is normal running speed is 3ft. per minute, but this can be increased to 12ft. per minute. Each screen is independently operated by two 2 B.H.P. motors.

After passing the screens the sewage enters the feed channel to the existing settlement tanks, and in due course to the contact beds.

Other works completed include houses for the decanted water pump and automatic penstock, a 20ft. wide channel carrying storm-water from the overflow cill to the old screening chamber, new entrance road to a block of new offices, messroom, store and stables, and a new laboratory. The new work has entailed various small alterations and additions to the existing penstocks and channels, which have been carried out.

The main delivering sludge on to the land at Flixton has been in commission throughout the year.

Detailed drawings of the activated sludge units are nearing completion, and a full description is reserved for a future report, when the new plant is ready to be brought into commission.

The cost of the completed work is £96,000.

Power Supply.

The steam plant was displaced in September, 1923, and since February 2nd, 1924, the works have been supplied with current by the Corporation Electricity Department by direct cable from the Barton Power Station, at a pressure of 6,600 volts to two 250 K.V.A. transformers, where it is stepped down to 440 volts for power and 220 volts for lighting purposes.

Panel switch-boards, complete with main cut-outs and meters, are provided for both high and low tension current.

The motors throughout the works are designed for 3-phase, 50 cycle A.C. current, and have a total working output of 500 B.H P.

There are two 60 B.H.P. motors for driving Alley-McLellan air compressors (high pressure) for operating sludge ejectors and sludge presses ; two 47 B.H.P. motors driving two 10in. Gwynne " Invincible " pumps, each capable of delivering 2,500 gallons per minute against a 40 foot head, employed for pumping off top water from sedimentation and septic tanks prior to removal of sludge ; one 35 B.H.P. motor driving the new activated-sludge compressor and three 30 B.H.P. motors for driving three Reavell air compressors (low pressure) intermittently employed in connection with the activated-sludge plant ; one 30 B.H.P. motor driving a Ruggles-Coles dryer, and one 24 B.H.P. motor also used in connection with sludge drying ; one 20 B.H.P. motor used for driving

purposes in the fitting shop ; two 20 B.H.P. motors for operating sewage screens and elevators ; two 10 B.H.P. motors for operating the two clinker washing plants ; and small motors from 1·5 to 10 B.H.P. used for sundry other purposes.

Drainage of the Parish of Davyhulme.

Some time ago an agreement was entered into with the Barton Rural District Council to treat the sewage from the Davyhulme Parish at the Davyhulme Works.

The sewage contributed by the population in Crofts Bank Road, Barton Road (part of), Davyhulme Road, and Bent Lanes is discharged at two points—*i.e.*, Point " C " and Point " E." That discharged at Point " C " passes over shallow filter beds, and then into the feed channel to the secondary beds.

The sewage delivered at Point " E " is conveyed by means of a 2ft. diameter brick sewer, on which a storm-water overflow is fixed at the Bent Lanes Brook, and which is intended to limit the volume of sewage passed on the estate of the Corporation. The sewage is delivered into a manhole referred to in the Agreement as Point " E," and from which it gravitates through three 6in. diameter cast-iron pipes to a " recorder chamber," where the flow is measured by means of a " V " notch of the type designed by Messrs. Lea, of Manchester, and has a maximum recording capacity of 10,000 gallons per hour. After passing over the notch the sewage flows on to pneumatic ejectors of 200 gallons capacity, in duplicate, each fixed in cast-iron tubbing.

These ejectors raise the sewage by means of compressed air, supplied from the main engine house at the works, into the feed channel supplying the existing septic tanks.

Area of Land.

The total area of land comprising the Davyhulme Works amounts to 254·0 acres, and is divided up as follows :—

	Acres
Land occupied by storm-water, detritus, open septic tanks, and activated-sludge plant	15·0
Land occupied by buildings, sludge tanks, etc., and land occupied in connection therewith..	15·0
Land occupied as wharves, lay-byes, and storage	5·0
Land occupied by first contact bacteria beds..	46·0
Land occupied by second contact bacteria beds	39·0
Land occupied by storm-water filters	26·8
The area of land not occupied by bacteria beds, buildings, tanks, etc., but includes existing roads, railway and embankments, and disused river bed..	107·2
Grand total	254·0

Tenancies, etc., of Land.

During the year covered by this Report the Committee's lands at Carrington and Flixton have been supervised from the Town Hall as heretofore, and periodical inspections of crops have been made by the officer of the Agricultural Committee of the Corporation. Certain fencing has been erected at Flixton.

There have been several changes of tenancy during the year, and one reduction of rental agreed to owing to the depreciated value of the land as a result of the passage of the sludge main.

The whole of the Flixton lands in the River Mersey meadows continues to be used by the Rivers Department either for crops or for sludge disposal operations. The erection of the Gas Department's bridge across the river has been the cause of considerable trespass over the Rivers Department's land at Carrington and Flixton. The provision of gates by the Gas Department has now reduced the number of offenders.

The total area of land let to farmers, etc., at the date of this Report is approximately as follows :—

	Area a. r. p.	Annual Rental £ s. d.
Townships of Stretford and Davyhulme	11 0 11	16 10 4
Township of Carrington ..	89 3 10½	108 15 10
Township of Flixton	60 2 31	120 9 4
Totals ..	160 6 12½	245 15 6

It has been decided to redeem the land tax on certain of the Committee's lands at Carrington and Flixton.

River Mersey Banks.

Extensive repairs have been carried out in two sections to the banks of the River Mersey at Flixton and Carrington. As the Department were convinced that the slips were entirely due to the presence of the Gas Department's lattice girder bridge, which collapsed into the river in October, 1927, and lay there for many months, the Gas Committee

agreed to pay half of the cost of the first section of repairs and the entire cost of the second section, the Rivers Department agreeing to instal protective piling round the two concrete pillars which carry the new bridge. All this work has been completed successfully during the year. The Gas Department's bridge has also been replaced during the year, and the installation of the high-pressure main across the Rivers Department's land completed. A right of way across the bridge has been reserved by the Rivers Department for the future use of their employees when sludging operations are to be extended to the Carrington side of the river.

Disputed Right of Way at Flixton.

Following a change of tenancy on the Flixton Estate, a dispute arose with the Entwisle Estate authorities at Davyhulme regarding the Department's right of vehicular access to certain fields adjoining the Hulme's Bridge Ferry, Woodsend Road, Flixton. As unrestricted access was considered vital (particularly as one of the fields was a " key " field, providing a way to another field on the bank of the Manchester Ship Canal to which there was no other access) the attitude of the Entwisle Estate was resisted. Many conferences took place on the site and in the Town Hall, the Town Clerk was called upon to produce old deeds and plans in support of the Department's case, and evidence was taken from several old inhabitants regarding ancient user of the road. Finally, the Department were able to satisfy the agent of the Entwisle Estate that the Corporation possessed adequate documentary evidence of their right of vehicular user of the disputed right of way.

Volume of Sewage Treated.

The volume of sewage delivered at the works from March 29th, 1928, to March 27th, 1929 (inclusive), including 30,808,000 gallons from the Parish of Davyhulme, was 16,597,536,000 gallons.

The average daily flow of sewage was 45,598,000 gallons, showing a decrease on the previous year of 5,583,000 gallons, or 10·9 per cent.

The average daily flow of sewage per head of population has ranged from a minimum of 52 gallons for the four weeks ending May 23rd, 1928, to a maximum of 78 gallons for the four weeks ending December 5th, 1928.

Monthly Recorded Sewage Flow and Rainfall.

Period of four weeks ending	Sewage		Rainfall				
	Flow	Average Daily Flow	Davyhulme	Oldham Road	Platt Fields	Heaton Park	Godlee Observatory
	Gallons	Gallons per head	Inches	Inches	Inches	Inches	Inches
1928							
April 25th	1,149,271,000	54	1·510	0·90	1·52	1 67	1·216
May 23rd	1,112,704,000	52	1·800	1·32	1·55	1·36	1·270
June 20th	1,308,941,000	61	3·810	3·54	3·44	3·51	3·329
July 18th	1,384,592,000	64	3·770	3·23	3·07	3·82	2·865
August 15th	1,160,711,000	54	2·565	2·49	2·81	2·54	2·459
September 12th	1,373,952,000	64	3·310	4·16	3·83	4·20	4·015
October 10th.....	1,138,848,000	53	2 205	2 38	2·16	2·11	2·298
November 7th	1,252,612,000	58	2·925	2·40	1·95	3·02	1 967
December 5th	1,676,096,000	78	4·750	4·98	4·18	5·63	4·539
1929							
January 2nd.....	1,250,115,000	58	2·160	2·24	1·78	2·55	2·076
January 30th.....	1,292,815,000	60	1·720	1·79	1·55	1·49	1 604
February 27th	1,280,056,000	60	0·550	1·09	1·07	1·40	1·262
March 27th	1,216,823,000	57	1·020	1·03	0·88	1·23	0·928
Totals for 52 weeks.....	16,597,53[illegible],000	60	32·095	31·55	29·79	34·53	29·828
Totals for 52 weeks ending March 28th, 1928	18,629,970,000	65	42·80	44·31	39·44	49·19	40·551

The number of days on which a measurable fall of rain (·01 inch or over) occurred during the 52 weeks was as follows :—

Davyhulme	163 days.
Oldham Road	168 „
Platt Fields	177 „
Heaton Park	184 „
Godlee Observatory ..	164 „

Total Volume of Sewage Filtered.

The total volume of sewage dealt with by the various filter beds (primary contact and storm-water filters) and by the activated-sludge process during the year amounted to 8,111,126,000 gallons, or 49 per cent. of the total flow of sewage.

Of the total quantity thus dealt with, 5,739,417,000 gallons were treated on the secondary filter beds. This volume is equal to 71 per cent. of the primary effluent, or 35 per cent. of the total sewage flow.

Practically the whole of the unfiltered sewage received treatment in sedimentation tanks prior to its discharge to the canal.

Particulars of the quantities and composition of the raw sewage and unfiltered tank effluent are given in Tables IV. and VII., together with comparative figures for the year ending March 28th, 1928.

The rate of the conversion of pail-closets during the past twenty-five years is given in the following table :—

Period	Number of Pail-closets converted
1905–1909	45,567
1910–1914	34,359
1915–1919	1,071
1920–1924	92
1925–1929	29

There are now comparatively few houses not served by the water-carriage system.

The amount of suspended matter in the sewage and various effluents, together with the comparative figures for two preceding years, is given in Table XV.

Sludge Disposal.

The total sludge production during the year was 250,114 tons, which is equal to 14·75 tons per million gallons sewage treated. Of this amount 172,734 tons were sent out to sea, 68,111 tons were pumped to Flixton and deposited on land, and 9,269 tons of water or thin sludge were decanted from the sludge storage tanks (prior to loading the steamer), and discharged on to drainage beds.

During the year the sludge steamer "Joseph Thompson" made 178 voyages, an average of 3·42 trips per week. The total mileage covered was 23,140 (statute), an average of 445 miles per week. The total coal consumption was 2,114 tons, an average of 11·9 tons per trip.

The new sludge main from the Davyhulme Works to the Committee's land at Flixton (some $2\frac{1}{2}$ miles distant) was available for use during the whole of the year reported upon. One hundred acres of land are at once available here for the disposal of sludge, and, if required, a further large area of land on the Carrington side of the river can readily be brought into commission.

As a result of the trials referred to in the last report it has been demonstrated that the most satisfactory utilisation of the land is to broadcast the sludge on lightly ploughed land, with subsequent ploughing to thoroughly incorporate the sludge into the soil.

During the year a total of 68,111 tons of sludge has been dealt with on 34 acres of this land area.

Particulars of the actual cost of this work are given in Table IV. and a critical examination of the cost of this method of sludge disposal in comparison with the cost of sea disposal is given in the following statement :—

In order to provide figures strictly comparable, the amounts expended have been treated as Capital or Revenue according to the nature of the work, although actually, for convenience, certain charges of a Capital nature were paid out of Revenue Account. Further, to overcome the anomaly of comparing Capital costs on a post-war basis in respect of the sludge pumping plant with Capital costs on a pre-war basis in respect of the sludge steamer, the sludge steamer Capital costs given below have been calculated on the approximate cost of a similar vessel to the "Joseph Thompson" given by the same builders in 1926, namely £40,000.

The figures are as follows :—

*Operating Costs.**

Sea Disposal :—					
Quantity of sludge deposited at sea					172,734 tons
Running cost :—	£	s.	d.		
Routine charges	7,252	5	9		
Canal tolls, insurance, etc.	1,774	11	9		
Owners' repairs and renewals	1,363	1	4		
Loading pipe maintenance	59	10	1		
				£10,449	8 11
Cost per ton of sludge					14·52d.
Land Disposal :—					
Quantity of sludge deposited on land					68,111 tons
Running cost :—	£	s.	d.		
Ploughing and gripping	887	17	5		
Engine and pump operation	215	16	9		
Engine and pump maintenance ..	12	3	9		
Main and distribution pipe maintenance	4	6	11		
				£1,120	4 10
Cost per ton of sludge					3·95d.

* These figures refer to labour, materials, services, and workshop costs only; no general works expenses are included.

Capital Costs.

Sea Disposal :—

	Capital Charge	Period of Years	Interest and Sinking Fund Charges
	£		£
Sludge steamer ..	40,000	30	2,840
Jetty	5,293	30	376
			3,216
Cost per ton of sludge			4·47d.

Land Disposal :—

	Capital Charge	Period of Years	Interest and Sinking Fund Charges
	£		£
Sludge main	8,067	30	573
Land drainage ..	276	30	20
Sludge pump and engine	1,216	15	126
Land (estimated) ..	15,000	60	842
			1,561
Cost per ton of sludge			5·50d.

Combined Capital and Operating Costs.

Sea Disposal	per ton	18·99d.
Land Disposal	per ton	9·45d.

Sludge Steamer Jetty.

A new and larger jetty has been erected on the Manchester Ship Canal below Barton Locks for the use of the sludge steamer "Joseph Thompson," The design and erection were left entirely in the hands of the Canal Company, and the cost of the work was £5,293 8s. 4d.

Detritus Tanks and Screens.

The new detritus tanks and screens (described on pages 21 and 22 of this report) were first utilised on the 22nd November, 1928, and were brought into full commission at the beginning of 1929. During the last quarter of the year reported upon the whole of the sewage was passed through the new plant, to allow of the completion of the remaining portion of the open sewage carrier and the storm-water cill, and the widening and reconstruction of the carrier connecting with the old screening chamber.

The total weight of material removed from the detritus tanks was 9,358 tons, of which 7,621 tons were removed during the quarter ending March, 1929, from a total sewage flow of 4,088 million gallons, being equal to 1·86 tons of detritus, etc. per million gallons of sewage treated.

The "Brackett" screens have only dealt with sewage flows up to the rate of 80 million gallons per day, the maximum rate they were designed to treat; the excess flows being bye-passed to the sedimentation tanks.

As anticipated, by obviating the formation of banks of heavy sludge, the operations of this new plant has had a marked effect in facilitating the removal of sludge from the sedimentation tanks.

Treatment of the Sewage in Sedimentation Tanks.

Sedimentation Tanks.

The six tanks referred to in the report for the year ending March, 1917, have been in operation as sedimentation tanks throughout the 12 months under observation.

The total flow through these tanks (water-holding capacity, 6,750,000 gallons) during the year amounted to 8,486,410,000 gallons, or 23,314,000 gallons per day.

In the following table particulars are given of the amount and character of the sludge removed from the individual tanks :—

Tank No.	Sludge Tons	Per cent. Water
6	14,299	89·4
7	23,110	89·5
8	22,804	89·9
9	21,569	88·5
10	32,208	89·8
11	29,000	89·3

The total quantity of sludge removed from the sedimentation tanks was 142,990 tons, or 16·8 tons per million gallons treated. The amount of sludge removed from these tanks is equal to 60 per cent. of the total tank sludge production.

Storm Beds.

The burning *in situ* of the media of this disused filtration area has been discontinued owing to complaints of aerial nuisance. The beds in the easterly area are being emptied with the view of providing tipping space for waste material, such as detritus, etc. In so far as it is economical, the media is being washed and re-used in the primary contact beds.

Treatment of the Sewage in Open Septic Tanks and Bacteria Beds.

Open Septic Tanks.

There are now 10 tanks in operation as open septic tanks. The length of each tank is 300 feet, and the width and depth of five of the tanks is 100 feet and 6 feet (average) respectively ; the other four tanks are shallower, but of greater width, while No. 12 tank (a portion of which is occupied by the activated-sludge unit) is now only 66 feet wide.

The total holding capacity of the 10 tanks is about 12,000,000 gallons.

The total flow of sewage through the septic tanks during the year amounted to 8,111,126,000 gallons, or 22,283,000 gallons per day.

In the following table are given details of the amount and character of the sludge removed from the various tanks :—

Tank No.	Sludge Tons	Per cent. Water
1	5,372	86·9
2	5,334	88·8
3	10,382	89·1
4	10,581	88·2
5	9,092	87·3
12	14,153	90·3
13	9,953	89·8
14	9,922	89·9
15	14,703	89·2
16	7,022	90·2

The total sludge removed from the septic tanks was 96,514 tons, an average of 11·9 tons per million gallons.

Half-acre Primary Beds.

This filtration area has dealt with a total volume of tank effluent of 7,924,020,000 gallons at an average rate (over the whole area) of 473,000 gallons per acre per day, or 88 gallons per cubic yard per day, as compared with last year's figure of 509,000 gallons per acre, or 94 gallons per cubic yard per day.

During the year under observation the washing, rescreening, and replacement of the media of 13 beds has been completed and the beds again placed in commission. These beds had been in operation for periods varying from five years three months to six years nine months since their previous renewal and had received from 6,000 to 7,900 fillings of tank effluent meanwhile.

The average analytical returns, showing the results of treatment together with the volumes of tank effluent dealt with, and comparative figures for the previous year, are given in Table VIII.

The operating, maintenance, and renewals cost are summarised in Table IV., together with particulars relating to the volumes of sewage treated on the various sections of the filtration areas.

SECONDARY BEDS.

Experimental Half-acre Bed No. 10a.

This bed has been in commission 24 years, and continues to receive 18 fillings per week, with suitable recuperative periods.

Reference to Table IX. will show that the volume of primary effluent treated was 52,212,000 gallons, an average (including all resting periods) of 286,000 gallons per acre per day, or 72 gallons per cubic yard per day. The analytical returns in this table show that the quality of the effluent has been well maintained.

No. 1 Secondary Bed.

This bed continues to be operated as a contact bed, receiving usually 12 fillings of primary effluent per week. The results obtained, as set out in Table X., show little variation from those yielded in previous years.

Second Contact Beds (Nos. 2 to 39).

The details of the construction of these beds are given in the Annual Report for the year ending March, 1929. The usual maintenance attention has been given to the surfaces of these beds, the cost of which is given in Table IV. Although during the period under observation no renewal work was undertaken on this filtration area, at the date of publication of this report renewal of the fine surface layer of the media of certain of these beds is in progress.

The quantities of primary effluent treated, and the results of the analyses of the filtrates from the various sections of the secondary beds, are given in Tables XI. to XIV., together with the corresponding figures for the previous year.

SHIP CANAL WATER.

The results of the incubation test as applied to the canal water taken above the works outfall, together with a record of rainfall and air temperatures, are given in Diagram 1.

The low rainfall experienced during the year has been reflected in the general condition of the canal water, which was putrefactive over a longer total period than is normally the case.

The exceptionally dry weather in April, 1928, had the effect of rendering the canal water putrefactive (on incubation) even earlier than in the previous year, and, with a continuance of the drought until the third week in May, the canal water remained in this condition until the advent of heavy rainfall in the first half of June. Relatively wet weather in this month kept the canal water in a fairly satisfactory state until towards the end of July, when the effect of a low rainfall in that month became marked. The condition of the canal water improved very much, despite summer temperatures, as the result of heavy rainfall during the latter half of August, but this improvement was short-lived and throughout September, which was a very dry month, the canal water was again putrefactive. A wet autumn kept the water in a satisfactory state, which was maintained until towards the end of February, 1929, despite low rainfalls in December, January, and February, which is doubtless largely attributable to the lowered temperature during this period. Eventually, however, as the result of the abnormally prolonged drought conditions, the canal water again became putrefactive during the last month of the year reported upon.

Summary of Results (Davyhulme Works).

The following summary of the results of operation of the Davyhulme Works is submitted :—

Total sewage flow— Main outfall .. 16,566,728,000 Davyhulme Parish, Point "E," 30,808,000	= 16,597,536,000 gallons.
Total sludge removed	= 250,114 tons.
	= 14·75 tons per million gallons.
Total volume of sewage filtered (primary contact beds and storm beds)	= 7,924,020,000 gallons.
	= 47·7 per cent. of the total sewage flow.
Volume of sewage treated by the activated-sludge process	= 187,106,000 gallons.
	= 1·1 per cent. of the total sewage flow.
Total volume filtered by secondary beds	= 5,739,417,000 gallons.
	= 71 per cent. of the primary effluent.
	= 35 per cent. of the total sewage flow,

Total Revenue Cost (apart from Interest Charges and Repayment of Debt) :—

= £3 11s. 10·9d. per million gallons.

Average Cost per Head of Population—

	s.	d.
For year ending 27th March, 1929	= 1	6·8
For twenty-four years ending 27th March, 1929	= 1	2·9

Results of Treatment (expressed in grains per gallon).

Four hours oxygen absorption			Albuminoid ammonia		
Raw sewage	Average effluent, including unfiltered tank effluent	Percentage purification	Raw sewage	Average effluent, including unfiltered tank effluent	Percentage purification
7·25	3·90	46%	·625	·325	48%

In Table XVII. will be found particulars of the cost of sewage treatment at Davyhulme for the period 1896-1929, including the total outlay on sewage disposal works up to date, annual maintenance, and annual capital charge (payment of interest and repayment of debt), which has been estimated on the basis of 5 per cent. of the outlay to date. The costs are also given in terms of the amount per head of population. The percentage purification effected by the treatment of sewage during the different years is also shown, together with the estimated population connected to the sewers.

RESEARCH WORK.

Davyhulme Demonstration Activated-Sludge Tank.

Apart from periodic stoppages to allow of the cleansing of the preliminary sedimentation tank, this plant has been in continuous operation throughout the year under review, dealing with sewage freed from the bulk of the settleable suspended solids.

The performance of the plant is shown in the following tabular statement :—

Average daily volume of sewage treated .. .. 576,000 gallons

Average detention period (aeration and re-aeration chambers) .. .. 7·0 hours

Air consumption, 1·6 cubic feet free air per gallon of sewage treated.

Average analytical returns, expressed in grains per gallon.

	Raw sewage	Settled sewage	Effluent
Four hours oxygen absorption.. ..	7·08	6·05	1·65
Free and saline ammonia	2·30	2·44	2·07
Albuminoid ammonia	0·63	0·495	0·16
Nitrite and nitrate	—	—	0·09
Putrescibility	—	—	19½/325
Biochemical oxygen demand	—	—	1·51
Suspended solids	17·5	7·4	2·0

Consequent on the abnormally dry period during the closing months of the year, the average volume of sewage treated per day shows a slight reduction on that recorded for the previous year. Taking the December quarter separately, however, the average daily volume of sewage treated was 659,000 gallons, with an air consumption of 1·38 cubic feet free air per gallon of sewage treated and a detention period in the aeration and re-aeration tanks of 6·2 hours.

Withington Works: Future Requirements.

Since the two activated-sludge units were installed at the Withington Works there has been a constantly increasing dry weather flow of sewage at these works, consequent on the extension of the population in the drainage area. The increased burden thus thrown on the filtration area (primary and second beds) has now become such as to render it necessary to give careful consideration to the question of the most economical method of affording adequate treatment to this portion of the city sewage.

Alternative schemes are (I.) permanent diversion to the Davyhulme Works of that portion of the sewage over and above the effective capacity of the existing purification plant at the Withington Works, with provision for its treatment at Davyhulme, and (II.) modification or extension of the plant at the Withington Works.

The question is purely one of economics, and until certain possibilities in respect of alternative (II.) had been explored it appeared impossible to form a sound judgment on the issue. During the year under review, therefore, attention has been devoted to a serious consideration of the various ways the Withington Works might be modified or extended to cope adequately with the increasing sewage flow.

The possibility of increasing the effective capacity of the existing contact beds by renewal of the filtering media was dismissed as uneconomic, and, so far, the investigation has been concerned with an attempt to determine the relative merits of applying the activated-sludge process to the treatment of

(*a*) sedimentation tank effluent ;

(*b*) contact bed effluent ; and

(*c*) present final effluent, *i.e.*, combined effluents from contact beds and activated-sludge process ;

the economics of applying the process to the treatment of sewage deprived only of floating matters and of gross settleable solids being already established at these works.

This investigation has been conducted on a laboratory scale, employing the diffused air method of applying the process, worked on the " fill and draw " system.

The experiments concerned with the treatment of the works, present final effluent (*c*) were attended with indifferent success. The relatively small amount of " colloidal " and " suspended " matter rendered it very difficult to maintain the required volume of the right character of sludge to effect the necessary purification.

The results obtained in the treatment of sedimentation tank effluent and of contact bed effluent are summarised in the following statement. The analytical returns are expressed in grains per gallon, for ease of comparison with the results obtained (*vide* page of this report) from the two established units dealing with screened and detritus free sewage.

Treatment of Settled Sewage by the Activated-Sludge Process.

Average analytical returns, expressed in grains per gallon.

	Settled Sewage	Effluent 2½ hours aeration	Settled Sewage	Effluent 2 hours aeration	Settled Sewage	Effluent 1½ hours aeration	Settled Sewage	Effluent 1 hour aeration
Four hours oxygen absorption	3·06	·51	3·55	·64	2·65	·66	2·97	·78
Putreseibility	—	0/7	—	1/4	—	½/8	—	5½/7
Free and saline ammonia	2·98	2·15	3·31	2·50	3·34	3·15	3·75	3·75
Albuminoid ammonia	·74	·165	·76	·16	·65	·20	·71	·25
Nitrite, as NH_3	—	·02	—	·025	—	trace	—	Nil
Nitrate, as NH_3	—	·38	—	·11	—	·07	—	·045
Biochemical oxygen demand (Royal Commission test)	—	·65	—	·73	—	·93	—	2·10
Total number of fillings	61		65		57		45	
Fillings per day	7		8		8		8	

Remarks: Dry weather conditions. Settled sewage: average sample of eombined effluent from Emseher and sedimentation tanks.

Treatment of Contact Bed Effluent by the Activated-Sludge Process.

Average analytical returns, expressed in grains per gallon.

	(*a*) Nitrifying Sludge		(*b*) Non-Nitrifying Sludge			
	Contact Bed Effluent	Effluent 1 hour Aeration	Contact Bed Effluent	Effluent 1 hour Aeration	Contaet Bed Effluent	Effluent ¾ hour Aeration
Four hours oxygen absorption	1·08	·43	1·39	·52	·84	·47
Putrescibility	—	0/9	—	⅛/7	—	0/6
Free and saline ammonia	1·94	·46	2·35	1·65	1·29	1·27
Albuminoid ammonia	·28	·07	·27	·13	·18	·10
Nitrite, as NH_3	·02	·015	·015	trace	·01·	traee
Nitrate, as NH_3	·10	·86	·15	·24	·19	·22
Bioehemieal oxygen demand (Royal Commission test)	—	·71	—	1·06	—	1·11
Total number of fillings	71		80		25	
Number of fillings per day	12		8		12	

Briefly, these results indicate—

(i.) that the average sewage at these works, after removal of the bulk of the settleable solids, *i.e.*, the combined Emscher and sedimentation tank effluents, can be purified by the activated-sludge process at an appreciably higher rate than the corresponding screened and detritus free sewage. It is estimated that there would be a saving of approximately 30 per cent., both in the required capacity of the aeration tank and in the air consumption ;

(ii.) that, as compared with the treatment of screened and detritus free sewage, purification of the present contact bed effluent, by the activated-sludge process, may be accomplished in about one-third the time. with a corresponding reduction in the air consumption. In this process an almost negligible amount of surplus sludge would be produced.

On the conclusion of an investigation of the possible economic use of chlorine as an adjunct to a somewhat overburdened sewage purification plant, it should be possible to sum up the position and to decide which is the best course to adopt.

Sludge Disposal.

The question of the installation of a working-scale digestion tank for the separate secondary treatment of sludge, with recovery of the gaseous products, is still under consideration, but, as stated in the last report, and as demonstrated during the year under review, the capacity of the land area at Flixton, and, if required, at Carrington, for dealing with undigested sludge, is such that the matter cannot be considered as one of extreme urgency. It is, however, desirable that complete data should be acquired of the economic possibilities of the secondary digestion process, as applied to the sludge problem at Davyhulme, with the view of coping with the increased volumes of sludge which will have to be dealt with when the activated-sludge units, included in the extension scheme in progress, are brought into commission.

A study has been commenced of the comparative manurial value of digested and undigested sewage sludge, working both with pot cultures and field trials. Misfortune has attended the pot culture work, and the results of the field trials are not yet available. In view of the general tendency towards the adoption of secondary digestion as an adjunct to the problem of sludge disposal, the question is not without importance and is worth pursuing.

Treatment of Sewage containing Glucose.

In view of the rapid extension of industries in which there is the possibility of the resultant waste liquors containing glucose, and the general policy of admitting such waste liquors into the local sewerage

system wherever it is economically possible, it was thought desirable in local and national interests to study certain aspects of this question.

The results so far obtained of an investigation of the influence of glucose on the problem of sewage purification are given in Appendix I. to this report.

In presenting this preliminary survey it is recognised that the study is very incomplete, and that the subject requires further investigation before any precise views may be expressed, but it is thought that the results, such as they are, may be of definite interest to those concerned with this somewhat difficult problem.

Concluding Remarks.

The value of the land area at Flixton, in relieving the situation at Davyhulme in reference to sludge disposal, has been amply demonstrated during the year under review.

As anticipated in the last report, the new detritus tanks and screening chamber have been brought into commission, and the new laboratory has been occupied during the latter half of the year.

The preparation of the detailed drawings and consideration of the necessary equipment of the activated sludge units included in the extension scheme approved by the Ministry of Health is still incomplete, but it is anticipated that the detailed cost of this work will be laid before the Ministry by the end of the present year.

The opportunity is taken of acknowledging many appreciative letters from recipients of last year's report and of expressing the thanks of the Department to those authorities and individuals who have been good enough to reciprocate by sending articles or reports on the subject of sewage treatment.

In order to relieve congestion in the Town Hall, the Rivers Department have taken a lease of modern offices in the Ship Canal House, King Street, Manchester, whence the administrative work of the Department will be conducted until accommodation becomes available in the extension of the Town Hall.

On behalf of the Rivers Committee,

T. R. Hewlett,
Chairman.

16th September, 1929.

APPENDIX I.

Purification of Sewage containing Glucose.

1. Filtration Experiments.

Two similar percolating filters, 4ft. deep, were constructed from 6in. earthenware pipes filled with 1in. to 1½in. washed clinkers. They were treated with weak domestic sewage, at a rate of 75 gallons per cubic yard per day, until they became mature, and were producing effluents of similar character. One filter was then treated with sewage containing 0·1% glucose, whilst the other continued to receive normal sewage, the above rate of application being maintained throughout the experiments.

It was soon apparent that the addition of glucose had a marked deterrent effect on nitrification, the average analysés of the effluents obtained while operating at the above rate for a period of three weeks being as follows :—

Results expressed in parts per 100,000.

Nature of Sample	4 hours Oxygen Absorption	Ammoniacal Nitrogen	Albuminoid Nitrogen	Nitrous and Nitric Nitrogen	3 minutes Oxygen Absorption		*p*H Values	Glucose
					Before Incubation	After Incubation		
Sewage alone ..	3·20	...	...	...	1·66	...	7·6	...
Effluent	1·50	0·61	0·18	1·17	·56	·64	7·4	...
Sewage + Glucose.	27·49	...	...	...	1·96	...	5·7	75·0
Effluent	9·57	0·42	0·205	0·11	1·30	1·19	6·7	25·0

The "acid reaction" produced by the addition of glucose was corrected with sodium carbonate, but this had no beneficial effect on the quality of the effluents obtained, as will be observed from the following analysés covering the subsequent period of three weeks :—

Nature of Sample	4 hours Oxygen Absorption	Ammoniacal Nitrogen	Albuminoid Nitrogen	Nitrous and Nitric Nitrogen	3 minutes Oxygen Absorption		*p*H Values	Glucose
					Before Incubation	After Incubation		
Sewage alone ..	4·56	...	...	...	2·56	...	7·8	...
Effluent	1·40	0·52	0·18	1·28	0·54	0·69	7·5	...
Sewage + Glucose.	16·31	...	...	...	2·43	...	6·9	4·6
Effluent	5·04	1·80	0·56	0·11	1·54	1·90	7·3	1·2

It will be seen from these tables that although sufficient glucose was added to produce a 0·1% solution the amount as actually determined 24 hours later was considerably less. In order to enquire more closely into the reason for this, a number of bottles were filled from the same sample of sewage to which the necessary amount of glucose had been added. Some of the bottles were tightly stoppered, so as to maintain anærobic conditions, and the remainder were connected in series and aerated by a stream of air bubbles. One bottle from each series was examined daily; the following results being typical:—

Results expresesd in parts per 100,000.

Examination Conducted	Aerated Sample			Non-Aerated Sample		
	*p*H Value	Glucose	4 hours Oxygen Absorption	*p*H Value	Glucose	4 hours Oxygen Absorption
At commencement ..	7·5	77·1	26·6	7·5	77·1	26·6
After 1 day	7·0	28·8	24·6	4·0	50·0	27·4
,, 2 days	6·0	20·3	21·0	3·5	22·2	27·1
,, 3 ,, ...	6·5	14·7	9·7	3·5	10·0	24·6
,, 4 ,, ...	7·0	7·2	5·0	3·5	Trace	24·4
,, 5 ,, ...	7·5	Nil	3·0	4·0	Nil	17·6

Comparison of the above results indicates that whereas the glucose steadily disappears under both conditions the change in the "P.H." value is much more marked when under anærobic conditions, and the character of the final product, as indicated by the oxygen absorption figure, is very different.

Stronger solutions of glucose behaved in a similar manner, and the addition of alkali to the samples under anærobic conditions did not produce any material effect.

There was no evidence of any sterilizing action due to glucose or its decomposition products.

2. Activated Sludge Experiments.

The apparatus used was similar to that described by Ardern and Lockett (c.f. Ann. Rept., 1916).

Four aeration vessels were employed, in which the following liquids were treated:—

(1) Sewage only (control).
(2) Sewage containing 0·05% glucose.
(3) ,, ,, 0·10% ,,
(4) ,, ,, 0·20% ,,

At the commencement of the experiment 10% by volume of activated sludge in good condition was placed in each aeration vessel and this volume was maintained throughout, any sludge in excess thereof being discarded. This step was rendered necessary by the rapid increase in volume of the sludges treating sewage and glucose. These sludges underwent a considerable change in colour during the course of the experiment, varying from the dark chocolate of the control to a very light grey when dealing with sewage + 0·20% glucose. One filling only was given per day in each case, and typical analysés indicating the purification effected at various times are given on next page.

TABLE 1.

Results in parts per 100,000.

No. of fillings from commencement	Nature of Sample	4 hours Oxygen Absorption	Ammoniacal Nitrogen	Albuminoid Nitrogen	Nitrous Nitrogen	Nitric Nitrogen	Incubation Test 3 minutes Oxygen Absorption	
							Before	After
2	Original sewage	2·40	1·81	0·38	0·01	Nil	0·94	0·43
	Control effluent	1·34	1·05	0·09	0·09	0·30	0·49	0·40
	0·05% glucose effluent..	4·94	0·82	0·23	0·14	0·16	0·91	4·69
	0·10% ,, ,, ..	10·71	0·64	0·22	0·14	0·20	0·77	3·40
	0·20% ,, ,, ..	16·40	0·76	0·15	0·14	Nil	1·06	1·83
4	Original sewage	2·97	2·80	0·39	Nil	0·10	1·26	4·40
	Control effluent	2·54	1·92	0·34	0·06	0·27	0·91	0·60
	0·05% glucose effluent..	2·34	0·58	0·31	0·02	0·06	0·77	0·89
	0·10% ,, ,, ..	2·34	Nil	0·35	Nil	0·05	0·63	1·09
	0·20% ,, ,, ..	34·46	Nil	0·50	Nil	0·07	1·60	2·66
5	Original sewage	2·63	1·46	0·32	Trace	0·05	0·97	2·31
	Control effluent	2·09	1·05	0·29	0·06	0·78	0·77	0·63
	0·05% glucose effluent..	1·97	0·06	0·25	0·02	0·22	0·66	0·74
	0·10% ,, ,, ..	3·14	Nil	0·36	Nil	0·13	0·69	1·54
	0·20% ,, ,, ..	47·43	Nil	0·30	Nil	0·15	1·89	1·54
6	Original sewage	5·03	2·74	0·51	Nil	0·19	1·63	5·00
	Control effluent	1·49	0·76	0·16	0·05	0·93	0·54	0·66
	0·05% glucose effluent..	2·03	Trace	0·30	0·03	0·08	0·74	0·66
	0·10% ,, ,, ..	2·17	Nil	0·29	Nil	0·06	0·60	1·09
	0·20% ,, ,, ..	17·51	Nil	0·36	Nil	0·06	1·54	3·71
37	Original sewage	5·94	4·26	0·81	Nil	0·10	2·26	3·83
	Control effluent	3·00	2·80	0·53	0·02	0·71	1·26	1·29
	0·05% glucose effluent..	1·97	1·98	0·42	0·04	0·16	0·83	0·74
	0·10% ,, ,, ..	2·74	0·99	0·49	Nil	0·05	1·09	1·29
	0·20% ,, ,, ..	7·71	0·64	0·33	Nil	0·15	1·46	2·46

(NOTE.—In some cases a distinct smell of butyric acid was present in the sample after incubation.)

These results indicate that the presence of even 0·05% of glucose in sewage is sufficient to interfere with nitrification, the effect being probably greater than would appear at first sight since the effluents obtained in the control experiment are affected by the considerable "over-blowing" subjected to.

Various aeration periods were subsequently employed, typical results obtained being as follows :—

TABLE 2.

Results in parts per 100,000.

No. of Fillings from Commencement	Aeration Period (hours)	Nature of Sample	4 hours Oxygen Absorption	Ammoniacal Nitrogen	Albuminoid Nitrogen	Nitrous Nitrogen	Nitric Nitrogen	Incubation Test: 3 minutes Oxygen Absorption		Biochemical Oxygen Demand
								Before	After	
67 ..	4	Original sewage	3·71	4·55	0·63	Nil	0·05	1·40	1·26	10·00
		Control effluent	1·26	2·98	0·18	·02	0·73	0·40	0·31	1·36
		0·05% glucose effluent	2·11	2·80	0·39	Nil	0·08	0·74	0·71	3·00
		0·10% glucose effluent	12·71	2·51	0·51	Nil	0·07	1·51	1·54	9·0
		0·20 % glucose effluent	38·00	3·10	0·53	Nil	0·05	1·74	1·97	9·0
76 ..	2	Original sewage	4·69	3·91	0·78	·01	0·12	2·17	2·46	...
		Control effluent	1·40	3·15	0·16	·01	0·29	0·60	0·46	1·67
		0·05% glucose effluent	5·29	3·08	0·59	Nil	0·12	1·37	1·97	8·0
		0·10% glucose effluent	6·80	2·33	0·36	Nil	0·12	1·20	1·69	6·5
		0·20% glucose effluent	14·11	3·38	0·46	Nil	0·13	2·43	3·43	...
117 ..	11	Original sewage	2·46	2·33	0·33	·01	0·12	0·97	1·09	8·43
		Control effluent	0·54	1·40	0·05	·02	0·41	0·23	0·26	0·33
		0·05% glucose effluent	1·20	Nill	0·28	Nil	0·07	0·49	0·57	1·97
		0·10% glucose effluent	1·83	Nil	0·33	Nil	0·03	0·63	0·71	3·71
		0·20% glucose effluent	27·90	Nil	0·36	·02	0·09	1·69	1·80	21·60

It will be seen from the results quoted in Table 1 that when sewage and glucose are aerated for 24 hours the whole of the ammoniacal nitrogen disappears, but no corresponding increase is to be found in the other forms of nitrogen present in the effluent. Subsequent investigations indicated that practically the whole of this nitrogen was "fixed" by the sludge. The gain being indicated, not by the increased percentage present but by the increase in bulk of the sludge produced, which was roughly proportional to the different amounts of glucose present in the three cases. The sludges were also examined microscopically with the following result :—

TABLE 3.

Microscopic examination of sludges.

Type	Control	0·05% Glucose	0·10% Glucose	0·20% Glucose
Bacteria	Few	Few	Many	Many
Protozoa	Very active	Fairly active	Sluggish	....
e.g., Carchesium	Present	Few present	Absent	Absent
Opercularia	Present	Present	Main type	Very few
Chœnia	Present	Present	Few	Absent
Aspidisca	Present	Few present	Absent	Absent
Podophyra	Present	Present	Few	Absent
Thread Growths	Absent	Traces	A few present	Very many
Moulds (mycelia), etc. ..	Absent	Absent	Traces	Present
Saccharomycetes..	Absent	Traces	Some present	Very many

In order to study the possible effect of the discharge of glucose effluents into sea water, the activated sludge experiments were continued, using the sludge which had been developed when treating sewage containing 0·20% glucose, with the addition of common salt. The sludge was divided equally between three aeration vessels and the following liquids added :—

(1) Sewage containing 0·20% glucose.

(2) Sewage containing 0·20% glucose and sodium chloride enough to make the whole of half sea-water strength.

(3) Sewage containing 0·20% glucose and sodium chloride enough to make the whole of full sea-water strength.

In the first series of experiments the volume of sludge present was maintained at 10% as measured after settlement for one hour and one filling was treated per day. The following table indicates the character of the results obtained :—

TABLE 4.

Results expressed in parts per 100,000.

No. of fillings from commencement	Nature of Sample	4 hours Oxygen Absorption	Ammoniacal Nitrogen	Albuminoid Nitrogen	Nitric Nitrogen	3 minutes Oxygen Absorption	Chloride	Biochemical Oxygen Demand
2	Sewage + 0·20% glucose.	60·20	1·91	0·68	0·08	6·57	19·1	31·7
	Control effluent	42·60	1·17	0·66	0·10	5·03	18·6	33·2
	½ sea-water effluent ..	26·80	0·70	0·58	·13	4·57	(1·5%)	29·1
	Full sea-water effluent..	38·20	1·05	0·53	0·07	5·14	(3·0%)	29·4
5	Sewage + 0·20% glucose.	46·60	2·27	0·34	0·06	2·34	9·1	25·0
	Control effluent	29·80	1·28	0·61	0·07	3·17	9·7	22·6
	½ sea-water effluent ..	23·60	1·22	0·51	0·08	3·26	(1·5%)	21·9
	Full sea-water effluent..	34·20	1·75	0·66	0·09	3·69	(3·0%)	23·1
	Sewage + 0·20% glucose.	56·60	2·92	1·02	Trace	3·77	7·1	85·0
	Control effluent	4·60	Trace	0·43	Trace	1·26	7·1	3·9
	½ sea-water effluent ..	14·20	Trace	0·68	Trace	2·43	(1·5%)	9·6
	Full sea-water effluent..	30·60	1·40	1·39	Trace	3·09	(3·0%)	41·1
	Sewage + 0·20% glucose.	70·80	1·75	0·75	Trace	2·97	7·1	...
	Control effluent	5·40	Trace	0·51	Trace	1·51	7·1	...
	½ sea-water effluent ..	10·40	Nil	1·15	Trace	2·20	(1·5%)	...
	Full sea-water effluent..	26·60	Trace	1·58	Trace	3·26	(3·0%)	...

A microscopical examination of the final sludges showed that the mould mycelia which were present in the control sludge were practically inhibited by the addition of salt and thread-like growths were reduced in number, so that it would appear unlikely that the disposal of glucose effluents in sea-water would be the cause of the promotion of mycelium growths, although the aerobic self-purification of the waste might be retarded.

In a further series of experiments, in which the period of aeration and the proportion of sludge present were varied, similar results were obtained.

The experimental work involved in this investigation has been carried out by R. Hicks, Assistant Chemist, under the supervision of the Resident Chemist (C. Jepson, M.Sc.), who is also responsible for the control of the activated-sludge plant at the Davyhulme Works.

Assisted by E. E. Jones, M.Sc., the Research Chemist (W. T. Lockett, M.Sc.) has been responsible for the research work at the Withington Works, described in the body of this report. The whole of the technical work of the Department is subject to the direction of the Consulting Chemist.

LIST OF TABLES, DIAGRAMS, AND PHOTOGRAPHS.

Table I.

GENERAL RIVERS WORK.

	£ s. d.	£ s. d.
Administration—		
Rivers Department	2,683 19 0	
Other Departments' Charges	50 10 1	
		2,734 9 1
Surveillance of Rivers and Streams and Trade Effluents		610 6 2
Green Lane Depot—		
Rents, Rates, Taxes, and Insurance	30 15 7	
Fabric Maintenance	0 11 9	
Tackle Maintenance	5 6 9	
General Cleaning and Sundries	19 13 10	
Workmen's Holidays	9 0 2	
		65 8 1
Westhead's Weir—		
Routine Operation	44 19 6	
Maintenance	43 10 11	
		88 10 5
Birley's Weir—		
Routine Operation	3 10 3	
Maintenance	0 0 0	
		3 10 3
Work in Rivers and Streams—		
River Medlock	102 6 5	
Corn Brook	7 14 6	
Gore Brook	2 5 7	
River Irwell	0 11 8	
Nico Ditch	1 0 0	
Crowcroft Brook	0 10 1	
Engineering Department Fares and Sundries	0 10 11	
Ley Brook	1 2 2	
Other Brooks or Watercourses	1 3 6	
		117 4 10
Contribution to Rivers Mersey and Irwell Joint Committee		1,950 0 0
Inspection of River Banks		2 0 10
Culverting of Rivers and Streams by Owners. Engineering Department's Supervision		44 10 0
Work for Outside Parties (Recoverable)		1 14 0
Settling Basin on River Medlock at Clayton		5 0 0
Upper Mersey Navigation Commission Expenses		9 17 1
		5,632 10 9
Less :		
Rents and Privileges	*8 3 11*	
Sale of Sundry Materials	*2 11 9*	
		10 15 8
		£5,621 15 1

Note.—In comparing these costs with the charge on the rates (*see* page 6) the sum of £166 10s. 5d. (overlapping accounts) must be deducted.

Cost of Sewage Treatment, 1928-29.

	£ s. d.	£ s. d.	
SCREENS AND CATCHPITS—			
Routine Cleaning and Operation	164 14 1		
High-level Screen Maintenance	3 9 5		
Low-level Screen Maintenance	3 3 8		
Conical Catchpit Detritus Removal	43 17 8		
Conical Catchpit Maintenance	0 12 11		
		215 17 9	
SETTLEMENT TANKS—			
Routine Cleaning and Operation	127 7 2		
Emscher Tank Maintenance	1 9 11		
		128 17 1	
SLUDGE DISPOSAL ON LAND—			
Digging, Filling, and Covering Grips and Lagoons	395 19 2		
Ejector and Pipe Maintenance	1 5 8		
Emscher Sludge Beds and Drying Ground	127 18 9		
Ejector House Maintenance	3 16 11		
Electric Current and Supervision	27 3 2		
Power House Charges (proportion)	106 3 4		
Air-Compressor Maintenance	12 3 8		
Installation of Sludge Pump	78 9 4		
		753 0 0	
BACTERIA BEDS—			
Routine Operation	304 1 10		
Primary Beds: Medium Surface Maintenance	546 8 7		
Secondary Beds: Medium Surface Maintenance	420 4 8		
Storm Beds: Medium Surface Maintenance	7 19 11		
Storm Beds: Fabric Maintenance	1 12 10		
		1,280 7 10	
CARRIERS—			
Routine Cleaning		15 3 3	
ACTIVATED-SLUDGE PLANTS—			
No. 1 Plant:			
Routine Operation	95 11 8		
Tank Fabric Maintenance	1 4 3		
Tank Equipment Maintenance	104 9 8		
No. 2 Plant:			
Routine Operation	136 14 1		
Tank Fabric Maintenance	5 2 11		
Tank Equipment Maintenance	48 17 11		
Electric Current and Supervision	869 0 9		
Power House Charges (proportion)	212 6 8		
No. 1 (Jones & Attwood) Compressor Maintenance	24 15 0		
No. 2 (Jones & Attwood) Compressor Maintenance	3 7 5		
No. 3 (Tilghman) Compressor Maintenance	35 5 2		
		1,536 15 6	
STORM-WATER PUMP AND RESERVOIR—			
Pump Operation	4 8 3		
Pump Maintenance	17 3 8		
Pump House Maintenance	8 5 8		
Storm-water Reservoir Cleaning	1 4 4		
		31 1 11	
LABORATORY—			
Routine Work	455 1 5		
Building Maintenance	4 14 2		
Installation of Gas Main, Emscher Tank to Laboratory	21 15 0		
		481 10 7	
RIVER BANK AND CHORLTON BROOK BANK MAINTENANCE		(c) 7 12 5	
ROAD MAINTENANCE		17 5 8	
FENCING		16 11 11	
GREASE RECOVERY		(a) 12 0 3	
		£1.097 14s. 10d.	

	£ s. d.	£ s. d.
WORKS ADMINISTRATION—		
Routine Work	380 2 9	
Administrative Building Maintenance	2 14 4	
Foreman's Residence Maintenance	1 16 5	
		384 13 6
LAND CULTIVATION—		
Routine Work	309 3 4	
Implement Repairs	6 3 4	
		(b) 315 6 8
MONETARY ALLOWANCES—		
Sickness	1 15 2	
Workmen's Compensation	3 19 1	
Additional to Superannuation	46 10 9	
School Fees of Junior Assistant	23 18 0	
		76 3 0
COTTAGES—		
No. 1 Cottage Maintenance	9 2 5	
No. 2 Cottage Maintenance	2 0 3	
Tenancy Services	15 8 5	
		26 11 1
RENTS, RATES, TAXES, AND INSURANCE—		
Works	821 12 11	
Agricultural Land	41 8 8	
Meadows	9 17 10	
		872 19 5
PUMPING—		
Electric Current and Supervision	371 17 0	
Power House Charges (proportion)	424 13 3	
No. 1 (19in.) Pump Maintenance	0 8 8	
No. 2 (10in.) Pump Maintenance	1 10 5	
No. 3 (10in.) Pump Maintenance	1 4 9	
No. 4 (15in.) Pump Maintenance	0 7 0	
No. 5 (2in.) Pump Maintenance	1 17 10	
		801 18 11
WEED REMOVAL AND DISPOSAL		30 4 6
SUNDRY UNCLASSIFIED ITEMS		26 2 1
UNEMPLOYMENT RELIEF WORK—		
Consolidation of River Mersey Banks	(c) 334 14 2	
Less: Refunded by Board of Guardians	*120 7 8*	
		214 6 6
		7,244 9 10
Less:		
Sale of Grease	(a) *67 16 0*	
Sale of Farm Produce	*262 17 11*	
Farm Produce Consumed in Stables	*60 18 3*	
	(b) *323 16 2*	
Sale of Sundry Materials	*26 15 2*	
Rents of Cottages and Meadows	*120 0 1*	
		538 7 5
		£6,706 2 5

	£ s. d.
Average cost per million gallons	4 13 9·9
Average cost per million gallons for year ended 28th March, 1928	3 14 10·5
Average cost per head of population connected to sewers	0 1 9·1
Average cost per head of population connected to sewers for year ended 28th March, 1928	0 1 8·8

NOTE.—In comparing these costs with the charge on the rates (*see* page 6) £83 9s. 2d. (produce from farm and overlapping accounts) must be added.

Table III.

MOSS SIDE SEWAGE WORKS.

	£ s. d.	£ s. d.
BUILDING MAINTENANCE—		
Caretaker's Residence	19 12 4	
Tenant's Residence	1 19 5	
Outbuildings	1 10 5	
		23 2 2
SLUDGE LAGOONS		35 7 6
CARRIERS		0 17 4
GENERAL CLEANING AND SUNDRIES		15 8 8
CARETAKER'S EMOLUMENTS		6 2 8
RENTS, RATES, TAXES, AND INSURANCE		35 5 2
SUPERVISION		16 16 7
TENANCY SERVICES		2 0 0
		135 0 1
Less :		
Rent of House, Privileges, and Sundries		*72 5 0*
		62 15 1
UNEMPLOYMENT RELIEF WORK—		
Ousel Brook Bank Repairs	159 17 6	
Less : Refunded by Board of Guardians	*83 1 3*	
		76 16 3
		£139 11 4

In comparing these costs with the charge on the rates the sum of £3 2s. 8d. in respect of overlapping accounts must be deducted.

MIDDLETON SEWAGE WORKS.

	£ s. d.	£ s. d.
SUPERVISION		34 5 7
RENTS, RATES, TAXES, AND INSURANCE		40 9 6
SETTLEMENT TANKS		48 16 7
SLUDGE LAGOONS		6 10 1
GENERAL TOOLS AND PLANT AND SUNDRIES		2 5 3
		132 7 0
Less :		
Rent of Building	*20 0 0*	
Sale of Sundry Materials	*23 2 0*	
		43 2 0
		89 5 0
UNEMPLOYMENT RELIEF WORK—		
Construction of Sludge Lagoons and Consolidation of River Irk Bank	300 13 7	
Less : Refunded by Board of Guardians	*134 12 8*	
		166 0 11
		£255 5 11

In comparing these costs with the charge on the rates the sum of £89 2s. 9d. in respect of overlapping accounts must be added.

GORTON SEWAGE WORKS.

	£ s. d.
CLEANING, FENCING, AND WEED DISPOSAL	18 19 5
SUPERVISION	16 15 6
RENTS, RATES, TAXES, AND INSURANCE	330 4 2
	£365 19 1

In comparing these costs with the charge on the rates the sum of 5s. 2d. in respect of overlapping accounts must be deducted.

Sludge, Screen Refuse, and Detritus.

Quarter ending	Sludge Produced	Trips run by Steamer	Screen Refuse No. 1 Plant	Screen Refuse No. 2 Plant	Detritus
1928	Tons		Tons	Tons	Tons
June 27th	70,332	49	2,205	...	...
September 26th	78,768	59	1,080	...	...
December 26th	50,143	36	1,088	10	1,737
1929					
March 27th	50,871	34	107	227	7,621
Total (52 weeks)	250,114	178	4,480	237	9,358
Average per week	4,810	3·42	...	...	...
Average per million gallons	15·07	...	...	...	...
Average for 52 weeks ending March 28th, 1928	10·62	Average per week 3·27	...	...	...
Average for 52 weeks ending March 30th, 1927	12·65	3·48	...	...	...

Memo.—172,734 tons deposited at sea; 68,111 tons pumped to Flixton and deposited on land; 9,269 tons water decanted from sludge storage tanks.

	£ s. d.
Cost for each trip run by Steamer (or 1/3·2 per ton of Sludge)	61 12 11

Filtration.

	Gallons.	Gallons.
Septic Tank Effluent dealt with by Primary Beds (46 acres):—		
Quarter ending June 27th, 1928	1,985,690,000	
,, ,, September 26th, 1928	2,051,080,000	
,, ,, December 26th, 1928	1,895,760,000	
,, ,, March 27th, 1929	1,991,490,000	
		7,924,020,000
Unfiltered Tank Effluent:—		
Quarter ending June 27th, 1928	1,879,855,000	
,, ,, September 26th, 1928	2,015,846,000	
,, ,, December 26th, 1928	2,538,959,000	
,, ,, March 27th, 1929	2,051,750,000	
		8,486,410,000
Activated Sludge Tank (No. 12):—		
Quarter ending June 27th, 1928	43,193,000	
,, ,, September 26th, 1928	48,165,000	
,, ,, December 26th, 1928	50,733,000	
,, ,, March 27th, 1929	45,015,000	
		187,106,000
Total Sewage Flow:—		
Quarter ending June 27th, 1928	3,908,738,000	
,, ,, September 26th, 1928	4,115,091,000	
,, ,, December 26th, 1928	4,485,452,000	16,597,536,000
,, ,, March 27th, 1929	4,088,255,000	
Effluent from Primary Beds, dealt with by Secondary Beds:—		
Quarter ending June 27th, 1928	1,340,738,000	
,, ,, September 26th, 1928	1,490,772,000	
,, ,, December 26th, 1928	1,471,395,000	
,, ,, March 27th, 1929	1,436,512,000	
		5,739,417,000

Average per Day.

	52 weeks ending March 27th, 1929	52 weeks ending March 28th, 1928	52 weeks ending March 30th, 1927
	Gallons.	Gallons.	Gallons.
Primary Beds	21,769,000	23,411,000	25,152,000
Unfiltered Tank Effluent	23,314,000	27,395,000	22,648,000
Activated Sludge Tank	514,000	375,000	311,000
Total Sewage Flow	45,597,000	51,181,000	48,111,000
Secondary Beds	15,768,000	15,819,000	16,017,000

Cost of Sewage Treatment, 1928-1929.

	£ s. d.	£ s. d.
Detritus Tanks:—		
Cleaning and Routine Operation	613 19 3	
Pumping off Supernatant Water	41 16 8	
		655 15 11
Screening:—		
No 1 Plant		
Cleaning and Routine Work	1,024 1 7	
No. 1 Screen Maintenance	128 14 8	
No. 2 Screen Maintenance	460 10 5	
Wagon and Rail Maintenance	22 15 1	
Chamber Maintenance	21 4 2	
	1,657 5 11	
Less Sale of Screenings	12 7 6	
		1,644 18 5
No. 2 Plant		
Cleaning and Routine Work	365 0 2	
No. 2 Screen Maintenance	7 2 8	
No. 3 Screen Maintenance	4 18 1	
No. 4 Screen Maintenance	3 12 8	
No. 5 Screen Maintenance	5 11 8	
		386 5 3
Settlement Tanks:—		
Cleaning and Routine Operation	1047 8 7	
Pumping off Supernatant Water	32 11 7	
Fabric Maintenance	180 18 9	
		1,260 18 11
Sludge Ejectors:—		
Routine Operation	939 3 7	
No. 1 Ejector Maintenance	89 8 10	
No. 2 Ejector Maintenance	12 11 11	
Air Main Maintenance	11 13 6	
Reserve Ejectors Maintenance	31 16 2	
1" Pump and Motor Maintenance	25 13 9	
Sludge Main Maintenance	44 14 1	
Ejector Chamber Maintenance	6 19 7	
		1,162 1 5
Sludge Storage Tanks and Steamer Loading:—		
Routine Cleaning and Operation	121 3 6	
Decanting Supernatant Water	8 13 0	
Tank Fabric Maintenance	14 12 1	
Loading Pipe Maintenance	63 3 5	
		207 12 0
Sludge Beds:—		
Routine Operation		49 18 6
Sludge Disposal on Land:—		
Sludge Ploughing and Gripping	965 9 11	
Engine and Pump Operation	301 14 0	
Engine and Pump Maintenance	11 15 10	
Sludge Main and Distribution Pipe Maintenance	4 10 8	
Installation of Oil Storage Tank and Widening of Footpath	145 11 7	
Land Draining	302 10 8	
		1,731 12 8
Sludge Steamer:—		
Routine Running	7,935 13 10	
Canal Tolls, Insurances and Licenses	1,942 6 4	
Owners' Repairs and Renewals	1,491 14 0	
Repairs Recoverable from Underwriters	329 6 6	
	11,699 0 8	
Less Recovered from Underwriters	725 15 5	
		10,973 5 3
Sludge Pressing:—		
Routine Work	25 1 2	
Plant Maintenance	6 2 11	
Building Maintenance	18 4 5	
		49 8 6
Dried Sewage Manure:—		
Routine Work	17 1 4	
Drier and Plant Maintenance	8 1 11	
Building Maintenance	52 18 9	
Agency Charges, Advertising, etc	1 4 8	
		79 6 8
Gauging Sewage Flow:—		
Routine Work		63 9 9
Primary Beds:—		
Routine Operation	2,009 14 9	
Medium Surface Maintenance	2,138 13 6	
Fabric Maintenance	120 13 1	
New Floor and Drains to Beds 1A and 2A	887 1 1	
	£ s. d.	
Medium Renewal	16,238 18 1	
Less Sale of Ashes	95 2 6	
	*16,143 15 7	
		21,299 18 0
Secondary Beds:—		
Routine Operation	1,353 10 0	
Medium Surface Maintenance	2,256 14 1	
Fabric Maintenance	67 18 5	
Medium Renewal	*554 11 1	
		4,232 13 7
Carriers:—		
Routine Cleaning	67 8 11	
Fabric Maintenance	21 5 2	
		88 14 1
Activated Sludge Plant:—		
Routine Operation	1,017 5 5	
Tank Fabric Maintenance	0 1 1	
Tank Equipment Maintenance	3 16 7	
Air Compressing Plant and House Maintenance	18 16 3	
		1,039 19 4
Grease Recovery:—		
Routine Work		(a) 248 6 6
Road Repairs:—		
Davyhulme Works	29 19 3	
Flixton Estate	58 19 1	
Carrington Estate	4 7 11	
		93 6 3
		£18,201 3s. 6d.
Fencing:—		
Davyhulme Works	61 10 6	
Flixton Estate	8 1 1	
		69 11 7
River Mersey Bank Repairs	1,791 4 6	
	£ s. d.	
Less: Refunded by Gas Department	806 8 2	
Refunded by Board of Guardians	392 7 9	
	1,198 15 11	
Land Cultivation:—		592 8 7
	£ s. d.	
Routine Work	1,164 0 6	
Implement Maintenance	35 18 1	
Farm Building Maintenance (Flixton)	60 17 9	
Experimental Cropping of Sludge Land	73 17 10	
	1,334 14 2	
Less: Sale of Produce	744 4 3	
Produce Consumed in Stables	172 9 1	
	916 13 4	
		418 0 10
Gardening		180 2 8
Laboratory:—		
Routine Work		1,983 10 6
Davyhulme Parish Sewage:—		
Screening and Pumping—Routine Operation	393 11 11	
Ejector Maintenance	7 15 9	
Air Main Maintenance	116 7 11	
Contact Beds—Medium Surface maintenance	22 2 9	
Recorder Maintenance	12 11 11	
Alterations to Pumping Plant	138 7 7	
Contact Beds—Fabric Maintenance	0 5 2	
Sewage Main Maintenance	43 10 4	
		734 13 4
Works Administration:—		
Routine Work	2,455 8 10	
Administrative Building Maintenance	37 14 5	
Manager's Residence Maintenance	77 7 11	
		2,570 11 2
Consulting Services *re* Sewage Disposal		964 12 3
Deputations and Committee Visits		241 18 3
Visiting Deputations Expenses		26 14 6
Monetary Allowances:—		
Sickness	110 16 8	
Workmen's Compensation	10 3 11	
Additional to Superannuation	51 1 11	
Compassionate (on Compulsory Retirement)	6 9 0	
		178 11 6
Contribution towards Cost of Bridge Across River Mersey at Carrington Constructed by Gas Department		210 0 0
Works Extensions:—		
Technical and Advisory Services	202 10 0	
Temporary Draughtsmen and Engineering Office Sundries	1,480 4 11	
Laying out Garden Plots	55 5 5	
Sludge Main to Flixton (Completion)	67 6 11	
Sundry Work	181 9 10	
		1,986 17 1
Rents, Rates, Taxes, and Insurance:—		
Davyhulme Works	4,432 16 1	
Flixton Estate and Buildings	149 7 2	
Carrington Estate and Buildings	60 4 0	
Land along line of Sewer	2 12 0	
		4,644 19 3
Dismantling Oliver Filter		67 17 7
Weed Removal and Disposal		99 6 9
Cleaning Ditches and Watercourses:—		
Davyhulme Works	15 12 10	
Flixton Estate	23 11 4	
		39 4 2
Conversion of Disused Laboratory to Garage and Cycle House		85 15 8
Erection of Stores Building on Flixton Estate		240 4 10
Land Tenancy Services		66 3 3
Sundry Unclassified Items		52 5 2
		60,720 19 11
Less:—		
Sale of Sewage Grease	(a) 683 4 3	
Sale of Scrap Metal and Sundry Materials	114 10 8	
Rents of Farm Lands and Privileges	244 9 6	
		1,042 4 5
		£59,678 15 6

	£ s. d.
Average cost per million gallons	3 11 10·9
Average cost per million gallons for year ended 30th March, 1928	3 3 3·9
Average cost per head of population connected to sewers	0 1 6 8
Average cost per head of population connected to sewers for year ended 30th March, 1928	0 1 6·6

In comparing these costs with the charge on the rates (see page 6), a Contribution of £15,046 19s. 0d. from the Local Authorities of Stretford, Middleton, Royton, Audenshaw, and Barton, sums of £2,577 10s. 2d. (expended out of Bacteria Beds Renewal Account) and £546 12s. 1d. (interest on Bacteria Beds Renewal Fund) must be deducted; and £172 9s. 1d. (materials produced on works), £205 5s. 6d. (overlapping accounts), and £169 13s. 1d. (costed to other works) must be added.

Washing.

*

Quantity.	Tons.
Fouled Medium Washed	29,241
Fouled Medium Rewashed	18,736
Storm Bed Medium Washed or Riddled	327
	18,304

Cost.	£ s. d.
No. 1 Washer	3,712 8 8
No. 2 Washer	2,955 12 11
Refuse from Washers	1,083 13 9
Loading and Delivering Ashes Sold	71 0 4
	7,822 15 8
Less Ashes Sold	95 2 6
	£7,727 13 2

Cost per ton 3s. 2·1d.

Summary.

	£ s.
Emptying Beds	2,861 5 1
Filling Beds	1,253 12 10
Washing Medium	7,727 13 2
Hauling to and from Beds	2,743 0 0
Hauling to Crusher, Crushing, and returning to Washer	1,936 19 10
Purchase of New Medium	175 15 9
	£16,698 6 8

Table V.

SUMMARY OF STATISTICS.

DAVYHULME SEWAGE WORKS.

SLUDGE DISPOSAL BY STEAMER—		
Cost per trip		£61 12 11
Cost per ton of sludge		0 1 3·2
SLUDGE DISPOSAL, AVERAGE COST PER TON		0 1 5·5
RAIL TRANSPORT—		
Cost per locomotive per operative hour		0 4 9·9
Coal consumed	tons	595·2
Average price of coal per ton		£1 1 10
HORSE TRANSPORT—		
"All-in" cost per horse per working hour		0 1 4·2
Cost of keep per horse per week		0 18 9·1
MOTOR TRANSPORT (30-cwt. "Morris")—		
Cost per operative hour		0 2 2·8
Miles run		9,612
Average mileage per week		184·8
Petrol consumption	gallons	780·5
Miles run per gallon of petrol		12·3
Net cost per mile run		£0 0 6·1
STEAM SHOVEL—Cost per operative hour		0 5 4·7
CRUSHER—Cost per operative hour		0 1 11·9
WORKSHOP EXPENSES (Cost per hour)—		
Locomotive Fitting Shop		0 0 4·8
General Fitting Shop		0 0 1·9
*Blacksmith's Shop		0 1 5·2
Joiner's Shop		0 0 1·6
Painter's Shop		0 0 4·2

* Including manufacture and repair of tools and cost of compressed air for hearths.

DAVYHULME SEWAGE WORKS.

TABLE VI.—COMPARATIVE ANNUAL COSTS, ETC., PERIOD 1925–26 to 1928–29.

Year	Total	Sludge produced	Trips run by steamer	Refuse from screens	Sewage flow	Cost per million gallons	Average population connected to sewers	Cost per head
	£ s. d.	Tons		Tons	Gallons	£ s. d.		£ s. d.
1925–26	57,268 17 7	236,101	199	4,925	18,172,380,000	3 3 0·4	754,000	0 1 6·2
1926–27	57,442 13 6	221,546	181	5,085	17,512,465,000	3 5 7·2	757,000	0 1 6·2
1927–28	58,984 7 3	197,792	170	5,042	18,629,970,000	3 3 3·9	760,200	0 1 6·6
1928–29	59,678 15 6	250,114	178		16,597,536,000	3 11 10 9	763,500	0 1 6·8

TABLE VII—SHOWING THE CHEMICAL COMPOSITION OF THE RAW SEWAGE (AVERAGE OF HOURLY SAMPLES) AND OF THE UNFILTERED TANK EFFLUENT, TOGETHER WITH THE RELATIVE VOLUMES OF EACH.

DATE	4 Hours oxygen absorption			Free and saline ammonia			Albuminoid ammonia			Nitrite (in terms of NH_3)	Nitrate (in terms of NH_3)	Chloride (in terms of Cl.)			INCUBATION TEST				Putrescibility	Total Quantity Gallons			Percentage of total flow dealt with on the filtration areas and by the activated sludge process
															3 Minutes oxygen absorption								
															Before incubation			After incubation					
Quarter ending	Manchester raw sewage	Davyhulme Parish sewage	Tank effluent	Manchester raw sewage	Davyhulme Parish sewage	Tank effluent	Manchester raw sewage	Davyhulme Parish sewage	Tank effluent	Tank effluent	Tank effluent	Manchester raw sewage	Davyhulme Parish sewage	Tank effluent	Manchester raw sewage	Davyhulme Parish sewage	Tank effluent	Tank effluent	Tank effluent	Total raw sewage	Davyhulme Parish sewage	Tank effluent (Unfiltered)	
1928																							
June 27th	7·62	4·08	6·89	2·36	2·65	2·65	·69	·605	·61	·01	·14	13·3	4·8	13·1	3·29	1·48	2·97	4·36	54/56	3,908,738,000	5,801,000	1,879,855,000	51·9
September 26th	6·95	4·80	5·39	2·01	2·66	2·20	·595	·68	·46	Trace	·11	13·7	7·2	13·0	3·14	1·77	2·51	3·63	61/61	4,115,091,000	9,075,000	2,051,846,000	51·0
December 26th	6·74	3·89	5·59	2·05	2·92	1·94	·59	·68	·465	·01	·09	12·5	4·8	11·7	3·05	1·50	2·57	3·04	40½/46	4,485,452,000	8,651,000	2,538,959,000	43·4
1929																							
March 27th	7·67	5·24	6·45	2·19	2·45	2·36	·625	·67	·515	·01	·12	13·8	5·0	13·1	3·19	1·83	2·74	4·00	62½/63	4,088,255,000	7,281,000	2,051,750,000	49·8
Average	7·25	4·50	6·08	2·16	2·67	2·29	·625	·66	·51	·01	·12	13·3	5·5	12·7	3·17	1·65	2·70	3·76	218/226	16,597,536,000	30,808,000	8,486,410,000	48·9
Average for year ending March 28th, 1928	7·20	2·99	6·05	2·02	1·93	2·11	·55	·455	·45	·01	·13	12·8	3·9	12·3	3·26	1.14	2·79	3·90	237/247	18,629,970,000	30,485,000	9,971,883,000	46·5

DAVYHULME WORKS.

Table VIII.

PRIMARY BEDS.—SERIES I., II., III., AND IIIa.

TABLE VIII.—SHOWING QUANTITY DEALT WITH, AND CHEMICAL COMPOSITION OF FILTRATE OBTAINED.

DATE	4 Hours oxygen absorption		Free and saline ammonia				Albuminoid ammonia				Nitrite (in terms of NH_3)			Nitrate (in terms of NH_3)			Chloride (in terms of Cl)					INCUBATION TEST: 3 Minutes oxygen absorption								Putrescibility			Quantity dealt with (Gallons)			Average quantity dealt with: Per acre per day (Gallons)			Average quantity dealt with: Per cubic yard per day (Gallons)		
																						Before incubation						After incubation														
QUARTER ENDING	Raw sewage	Tank effluent	Series I.	Series II.	Tank effluent	Series III. and IIIa.	Raw sewage	Tank effluent	Series I.	Series II.	Tank effluent	Series III. and IIIa.	Raw sewage	Tank effluent	Series I.	Series II.	Series III. and IIIa.	Raw sewage	Tank effluent	Series I.	Series II.	Tank effluent	Series III. and IIIa.	Raw sewage	Tank effluent	Series I.	Series II.	Tank effluent	Series III. and IIIa.	Series I.	Series II.	III. and IIIa.	Series I.	Series II.	III. and IIIa.	Series I.	Series II.	III. and IIIa.	Series I.	Series II.	III. and IIIa.
1928																																								
June 27th	7·62	7·11	3·35	3·23	6·10	2·69	2·36	2·37	1·81	1·88	2·72	2·19	·69	·46	·23	·225	·50	·26	·015	·01	·015	·14	·16	·15	13·3	14·0	12·8	13·1	11·2	10·5	3·29	3·22	1·71	1·65	2·79	1·32	2·00	2·01	1·83	10½/13	11/13	12/13	908,660,000	150,500,000	926,530,000	499,000	276,000	509,000	92	51	94
September 26th	6·95	6·14	2·98	2·67	4·81	2·10	2·04	2·11	1·38	1·32	2·43	1·72	·595	·42	·215	·205	·415	·23	·01	Trace	·02	·11	·12	·13	13·7	14·8	13·4	13·4	11·5	10·5	3·14	3·07	1·53	1·36	2·38	1·02	1·90	1·74	1·27	11/13	12/13	9½/13	967,140,000	167,960,000	915,980,000	531,000	308,000	503,000	98	57	93
December 26th	6·74	6·33	3·19	2·90	5·00	2·20	2·05	2·20	1·59	1·52	2·13	1·77	·59	·455	·245	·22	·435	·225	·01	Nil	·01	·09	·12	·23	12·5	14·1	13·1	13·5	11·1	9·7	3·05	3·11	1·65	1·52	2·40	1·11	1·86	1·75	1·08	5½/13	7/13	1½/11	897,500,000	257,020,000	741,240,000	493,000	471,000	407,000	91	87	75
1929																																								
March 27th	7·67	7·25	3·37	3·19	5·97	2·81	2·19	2·15	1·63	1·57	2·46	2·12	·625	·495	·23	·195	·455	·245	·01	Trace	·015	·09	·13	·15	13·8	14·9	13·6	13·5	13·6	12·1	3·19	3·21	1·64	1·54	2·70	1·37	2·23	2·11	1·64	11/13	11/13	7½/13	794,030,000	285,920,000	911,540,000	436,000	524,000	501,000	81	97	93
Average	7·25	6·71	3·22	3·00	5·47	2·45	2·16	2·21	1·60	1·57	2·44	1·95	·625	·46	·23	·21	·45	·24	·01	Trace	·015	·11	·13	·17	13·3	14·5	13·2	13·4	11·9	10·7	3·17	3·15	1·63	1·52	2·57	1·21	2·00	1·90	1·46	38/52	41/52	30½/50	3,567,330,000	861,400,000	3,495,290,000	490,000	394,000	480,000	91	73	89
Average for year ending March 28th, 1928	7·29	6·78	3·49	3·08	5·84	2·33	2·02	2·08	1·70	1·75	2·36	1·91	·55	·435	·245	·22	·43	·215	·015	·01	·015	·15	·16	·17	12·8	13·6	12·4	12·4	11·2	10·0	3·26	3·32	1·81	1·59	2·85	1·31	2·39	2·02	1·63	43½/51	42½/51	39/52	3,966,030,000	1,070,500,000	3,485,000,000	545,000	490,000	479,000	101	91	89

Purification effected																																									
	Calculated on tank effluent	52%	55%		55%												50%	54%		47%																						
	Corresponding purification for year ending March 28th, 1928	49%	55%		57%												44%	49%		50%																						
	Calculated on raw sewage	56%	59%		66%												63%	66%		62%																						
	Corresponding purification for year ending March 28th, 1928	52%	57%		65%												55%	60%		61%																						

DAVYHULME WORKS

HALF ACRE SECOND CONTACT BED—No. 10A.

TABLE IX.—SHOWING QUANTITY DEALT WITH AND CHEMICAL COMPOSITION OF FILTRATE OBTAINED.

Date	4 Hours oxygen absorption		Free and saline ammonia		Albuminoid ammonia		Nitrite (in terms of NH_3)		Nitrate (in terms of NH_3)		Chloride (in terms of Cl.)		Incubation test						Total quantity dealt with	Average quantity dealt with	
													3 Minutes oxygen absorption				Putrescibility			Per day	Per cubic yard per day
													Before incubation		After incubation						
Quarter ending	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Gallons	Gallons	Gallons
1928																					
June 27th.....	4·29	1·45	2·20	·96	·315	·13	nil	·025	·09	·81	12·4	12·5	2·11	·65	2·83	·63	13/13	0/10	13,680,000	150,000	75
September 26th.....	3·70	1·30	1·72	·78	·28	·125	·01	·02	·11	·85	12·9	12·6	1·84	·56	2·44	·48	12/13	0/9	12,312,000	135,000	68
December 26th.....	3·70	1·37	1·62	·80	·275	·14	·01	·015	·11	·79	12·9	11·6	1·89	·61	2·06	·51	7½/12	0/10	12,540,000	138,000	69
1929																					
March 27th	4·13	1·49	1·87	·95	·29	·135	·01	·01	·14	·76	13·1	12·5	1·98	·64	2·52	·47	13/13	0/10	13,680,000	150,000	75
Average	3·96	1·40	1·85	·87	·29	·13	·01	·015	·11	·80	12·8	12·3	1·96	·62	2·46	·52	45½/51	0/39	52,212,000	143,000	72
Average for year ending March 28th, 1928.....	4·05	1·32	1·85	·98	·295	·115	·015	·02	·13	·78	11·9	11·1	2·09	·61	2·78	·54	39/49	0/37	50,616,000	139,000	70

Purification effected	Calculated on primary effluent	65%	55%
	Corresponding purification for year ending March 28th, 1928	67%	61%
	Calculated on raw sewage	81%	79%
	Corresponding purification for year ending March 28th, 1928	82%	79%

DAVYHULME WORKS.

No. 1 SECONDARY BED

TABLE X.—SHOWING QUANTITY DEALT WITH AND CHEMICAL COMPOSITION OF FILTRATE OBTAINED.

Date	4 Hours oxygen absorption		Free and saline ammonia		Albuminoid ammonia		Nitrite (in terms of NH_3)		Nitrate (in terms of NH_3)		Chloride (in terms of Cl.)		Incubation test: 3 Minutes oxygen absorption				Putrescibility		Total quantity dealt with	Average quantity dealt with	
													Before incubation		After incubation					Per day	Per cubic yard per day
Quarter ending	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Gallons	Gallons	Gallons
June 27th, 1928	3·80	1·73	2·16	1·21	·31	·165	Trace	·02	·09	·52	11·8	12·4	2·02	·82	3·02	·81	22½/23	2½/23	56,160,000	617,000	96
September 26th, 1928	3·68	1·60	1·86	·98	·275	·145	·01	·03	·10	·53	12·5	12·9	1·89	·78	2·61	·68	23/24	0/24	56,160,000	617,000	96
December 26th, 1928	3·28	1·60	1·84	·95	·29	·135	·01	·015	·09	·61	11·3	12·3	1·71	·79	1·87	·64	8½/14	0/14	50,760,000	558,000	87
March 27th, 1929 ...	3·88	2·18	1·91	1·28	·275	·175	·01	·02	·13	·51	12·2	13·1	1·97	1·03	2·50	1·09	21½/26	7/24	51,840,000	570,000	89
Average	3·66	1·78	1·94	1·11	·29	·155	·01	·02	·10	·54	12·0	12·7	1·90	·86	2·50	·81	75½ 87	9½/85	214,920,000	590,000	92
Average for year ending March 28th, 1928	3·81	1·63	1·91	1·18	·29	·145	·01	·025	·11	·56	11·3	11·9	1·94	·80	2·75	·74	84/100	7½/97	218,880,000	601,000	94

Purification effected.			
	Calculated on primary effluent	51%	47%
	Corresponding purification for year ending March 28th, 1928	57%	50%
	Calculated on raw sewage	75%	75%
	Corresponding purification for year ending March 28th, 1928	77%	74%

DAVYHULME WORKS.

Table XI.

SECOND CONTACT BEDS—Nos. 5 to 19 (inclusive).

TABLE XI.—SHOWING QUANTITIES DEALT WITH AND CHEMICAL COMPOSITION OF FILTRATE.

DATE	4 Hours oxygen absorption		Free and saline ammonia		Albuminoid ammonia		Nitrite (in terms of NH_3)		Nitrate (in terms of NH_3)		Chloride (in terms of Cl.)		Incubation test: 3 Minutes oxygen absorption				Incubation test: Putrescibility		Quantity dealt with	Average quantity dealt with	
													Before incubation		After incubation					Per day	Per cubic yard per day
Quarter ending	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Gallons	Gallons	Gallons
June 27th, 1928 ...	3·80	1·79	2·16	1·15	·31	·155	Trace	·025	·09	·60	11·8	12·4	2·02	·84	3·02	·92	22½/23	4/23	482,982,000	5,307,000	88
September 26th, 1928	3·68	1·45	1·86	·85	·275	·13	·01	·02	·10	·59	12·5	12·9	1·89	·66	2·61	·62	23/24	1/24	470,802,000	5,174,000	86
December 26th, 1928	3·28	1·34	1·84	·95	·29	·13	·01	·015	·09	·71	11·3	11·1	1·71	·61	1·87	·51	8½/14	0/15	473,561,000	5,204,000	86
March 27th, 1929 ...	3·88	1 82	1·91	1·18	·275	·14	·01	·01	·13	·52	12·2	12·6	1·97	·85	2·50	·80	21½/26	3/26	457,482,000	5,027,000	83
Average	3·66	1·60	1·94	1·03	·29	·14	·01	·015	·10	·61	12·0	12·3	1·90	·74	2·50	·71	75½/87	8/88	1,884,827,000	5,178,000	86
Average for year ending Mar. 28th, 1928	3·81	1·48	1·91	1·10	·29	·135	·01	·02	·11	·59	11·3	11·5	1·94	·69	2·75	·67	84/100	4/100	1,886,304,000	5,182,000	86

Purification effected			
	Calculated on primary effluent	56%	52%
	Corresponding purification for year ending March 28th, 1928	61%	53%
	Calculated on raw sewage	78%	78%
	Corresponding purification for year ending March 28th, 1928	79%	75%

DAVYHULME WORKS.

SECOND CONTACT BEDS—Nos. 2 and 20 to 27 (inclusive).

TABLE XII.—SHOWING QUANTITIES DEALT WITH AND CHEMICAL COMPOSITION OF FILTRATE OBTAINED.

DATE	4 Hours oxygen absorption		Free and saline ammonia		Albuminoid ammonia		Nitrite (in terms of NH_3)		Nitrate (in terms of NH_3)		Chloride (in terms of Cl.)		Incubation test: 3 Minutes oxygen absorption				Incubation test: Putrescibility		Quantity dealt with	Average quantity dealt with	
													Before incubation		After incubation					Per day	Per cubic yard per day
Quarter ending	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Gallons	Gallons	Gallons
June 27th, 1928	3·80	1·70	2·16	1·11	·31	·155	Trace	·025	·09	·55	11·8	12·3	2·02	·78	3·02	·76	22½/23	3½/23	223,248,000	2,453,000	74
September 26th, 1928	3·68	1·43	1 86	·79	·275	·135	·01	·03	·10	·59	12·5	12·8	1·89	·67	2·61	·57	23/24	2½/24	217,332,000	2,388,000	72
December 26th, 1928	3·28	1·38	1·84	·82	·29	·125	·01	·015	·09	·70	11·3	11·7	1·71	·63	1·87	·50	8½/14	0/16	210,518,000	2,313,000	70
March 27th, 1929 ...	3·88	1·85	1·91	1·12	·275	·155	·01	·015	·13	·54	12·2	12·8	1·97	·86	2·50	·91	21½/26	7/26	211,910,000	2,329,000	71
Average	3·66	1·59	1·94	·96	·29	·14	·01	·02	·10	·60	12·0	12·4	1·90	·74	2·50	·69	75½/87	13/89	863,008,000	2,371,000	72
Average for year ending March 28th, 1928 ...	3·81	1·46	1·91	1·02	·29	·13	·01	·02	·11	·62	11·3	11·8	1·94	·70	2·75	·65	84/100	5/100	838,501,000	2,304,000	70

Purification effected			
	Calculated on primary effluent	57%	52%
	Corresponding purification for year ending March 28th, 1928	62%	55%
	Calculated on raw sewage	78%	78%
	Corresponding purification for year ending March 28th, 1928	80%	76%

TABLE XIII.—SHOWING QUANTITY DEALT WITH AND CHEMICAL COMPOSITION OF FILTRATE.

DATE	4 Hours oxygen absorption		Free and saline ammonia		Albuminoid ammonia		Nitrite (in terms of NH_3)		Nitrate (in terms of NH_3)		Chloride (in terms of Cl.)		Incubation test: 3 Minutes oxygen absorption				Incubation test: Putrescibility		Quantity dealt with	Average quantity dealt with	
													Before incubation		After incubation					Per day	Per cubic yard per day
Quarter ending	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Gallons	Gallons	Gallons
June 27th, 1928	4·29	1·61	2·20	·78	·315	·125	nil	·025	·09	·81	12·4	11·3	2·11	·76	2·83	·70	13/13	1/8	143,820,000	1,580,000	64
September 26th, 1928	3·70	1·25	1·72	·55	·28	·115	·01	·02	·11	·78	12·9	12·0	1·84	·55	2·44	·45	12/13	0/13	238,680,000	2,623,000	107
December 26th, 1928	3·70	1·40	1·62	·61	·275	·12	·01	·01	·11	·80	12·9	11·8	1·89	·65	2·06	·58	7½/12	0/13	238,680,000	2,623,000	107
March 27th, 1929 ...	4·13	1·72	1·87	·89	·29	·13	·01	·01	·14	·74	13·1	12·4	1·98	·78	2·52	·70	13/13	1/13	238,680,000	2,623,000	107
Average	3·96	1·50	1·85	·71	·29	·12	·01	·015	·11	·78	12·8	11·9	1·96	·69	2·46	·61	45½/51	2/47	859,860,000	2,362,000	96
Average for year ending March 28th, 1928 ...	4·05	1·32	1·85	·78	·295	·11	·015	·02	·13	·80	11·9	10·9	2·09	·61	2·78	·55	39/49	0/45	853,740,000	2,345,000	95

Purification effected			
	Calculated on primary effluent	62%	59%
	Corresponding purification for year ending March 28th, 1928.	67%	63%
	Calculated on raw sewage	79%	81%
	Corresponding purification for year ending March 28th, 1928.	82%	80%

DAVYHULME WORKS.

SECOND CONTACT BEDS—Nos. 36–39 (INCLUSIVE).

TABLE XIV.—SHOWING QUANTITY DEALT WITH AND CHEMICAL COMPOSITION OF FILTRATE.

DATE	4 Hours oxygen absorption		Free and saline ammonia		Albuminoid ammonia		Nitrite (in terms of NH_3)		Nitrate (in terms of NH_3)		Chloride (in terms of Cl.)		Incubation test: 3 Minutes oxygen absorption				Incubation test: Putrescibility		Quantity dealt with	Average quantity dealt with	
													Before incubation		After incubation					Per day	Per cubic yard per day
Quarter ending	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Primary effluent	Secondary effluent	Gallons	Gallons	Gallons
June 27th, 1928.....	4·29	1·41	2·20	·57	·315	·115	Nil	·02	·09	·89	12·4	11·5	2·11	·63	2·83	·56	13/13	0/10	189,720,000	2,085,000	92
September 26th, 1928	3·70	1·31	1·72	·61	·28	·115	·01	·025	·11	·77	12·9	11·9	1·84	·59	2·44	·47	12/13	0/13	238,680,000	2,623,000	116
December 26th, 1928	3·70	1·40	1·62	·62	·275	·12	·01	·01	·11	·77	12·9	11·8	1·89	·65	2·06	·53	7½/12	0/13	238,680,000	2,623,000	116
March 27th, 1929 ...	4·13	1·84	1·87	·98	·29	·14	·01	·01	·14	·66	13·1	12·5	1·98	·85	2·52	·73	13/13	0/12	229,500,000	2,522,000	111
Average	3·96	1 49	1·85	·70	·29	·12	·01	·015	·11	·77	12·8	11·9	1·96	·68	2·46	·57	45½/51	0/48	896,580,000	2,463,000	109
Average for year ending March 28th, 1928 ...	4·05	1·39	1·85	·80	·295	·12	·015	·02	·13	·82	11·9	11·1	2·09	·66	2·78	·57	39/49	0/47	894,540,000	2,457,000	108

Purification effected				
	Calculated on primary effluent	62 %		59 %
	Corresponding purification for year ending March 28th, 1928	66 %		59 %
	Calculated on raw sewage	79 %		81 %
	Corresponding purification for year ending March 28th, 1928	81 %		78 %

DAVYHULME WORKS.

TABLE XV.—SHOWING THE AMOUNT OF SUSPENDED SOLIDS CONTAINED IN THE SEWAGE, TANK EFFLUENTS, AND FILTRATES.

	RESULTS EXPRESSED IN GRAINS PER GALLON								
	Average for the year ending March 27th, 1929			Average for the year ending March 28th, 1928			Average for the year ending March 30th, 1927		
	Mineral	Organic and Volatile	Total	Mineral	Organic and Volatile	Total	Mineral	Organic and Volatile	Total
Sewage	6·5	11·5	18·0	7·6	11·4	19·0	8·0	12·5	20·5
Open Septic Tank Effluent (East)	3·1	4·7	7·8	4·2	5·5	9·7	2·6	3·9	6·5
Series I. (Beds 13 to 52)	1·8	2·7	4·5	2·3	3·1	5·4	1·5	2·5	4·0
Do. II. (Beds 1A to 10)	1·7	2·7	4·4	2·6	3·4	6·0	2·2	3·0	5·2
Open Septic Tank Effluent (West)	2·3	3·4	5·7	3·8	5·1	8·9	2·6	4·2	6·8
Series III. and IIIA (Beds 53 to 92)	1·3	2·4	3·7	1·9	2·6	4·5	1·7	2·4	4·1
Unfiltered Tank Effluent	3·4	5·7	9·1	4·4	6·2	10·6	4·0	6·0	10·0
Second Contact Bed (No. 10A)	·8	1·3	2·1	1·1	1·2	2·3	·7	1·0	1·7
Do. do. (No. 1)	·7	1·1	1·8	1·2	1·3	2·5	·7	1·0	1·7
Do. do. (Nos. 2 to 27 inclusive) ...	·7	1·2	1·9	1·3	1·3	2·6	·7	1·0	1·7
Do. do. (Nos. 32 to 39 inclusive) ...	·8	1·2	2·0	1 3	1·3	2·6	·9	1·0	1·9

TABLE XVI.—RESULTS OF EXAMINATION OF THE SHIP CANAL WATER ABOVE AND BELOW THE OUTFALL.

DATE	Four hours oxygen absorption		Free and saline ammonia		Albuminoid ammonia		Chloride (in terms of Cl.)		Incubation Test: 3 Minutes oxygen absorption: Before incubation		Incubation Test: 3 Minutes oxygen absorption: After incubation		Incubation Test: Putrescibility		Percentage rise in the 3 minutes oxygen absorption test after incubation	
Month	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
April 1928	·79	1·24	·42	·66	·08	·115	5·0	6·4	·33	·56	·50	·77	3½/8	3/8	—	—
May ,,	1·56	1·90	·74	·99	·14	·16	9·2	10·1	·71	·92	·91	1·28	9/9	9/9	—	—
June ,,	1·62	1·81	·74	·85	·155	·17	7·0	7·7	·68	·82	1·15	1·50	4/4	4/4	—	—
July ,,	·86	1·23	·48	·59	·115	·135	5·9	6·4	·35	·53	·57	·91	3½/10	5½/10	—	—
August ,,	·89	1·39	34	·50	·085	·11	5·7	6·7	·33	·63	·45	·99	2/8	4½/8	—	—
September ,,	1·34	1·84	·71	·91	·135	·155	8·2	8·9	·65	·97	·87	1·47	6/6	6/6	—	—
October ,,	1·04	1·75	·41	·63	·115	·14	5·9	7·0	·44	·82	·51	1·27	1½/5	2/5	—	—
November ,,	·61	·84	·14	·20	·045	·06	3·2	3·6	·20	·33	·20	·36	0/5	0/5	—	—
December ,,	·67	1·31	·19	·38	·085	·13	4·5	5·5	·29	·58	·26	·58	0/3	0/3	—	—
January 1929	·92	1·34	·35	·50	·105	·125	5·8	8·2	·37	·56	·45	·68	2/7	2½/7	—	—
February ,,	1·07	1·33	·45	·60	·10	·12	6·2	6·6	·38	·51	·41	·65	½/5	1½/5	—	—
March ,,	1·61	2·02	·64	·85	·145	·185	8·4	8·8	·69	·97	·91	1·11	2½/4	3½/4	—	—
Average	1·08	1·50	·47	·64	·11	·135	6·3	7·2	·45	·68	·60	·96	34½/74	41½/74	33%	41%
Average for year ending :— March, 1928	·86	1·18	·40	·53	·085	·11	5·0	5·7	·36	·53	·47	·70	23/80	31½/80	31%	32%
March, 1927	·93	1·21	·48	·60	·095	·12	5·5	6·3	·37	·53	·50	·73	24/81	35½/81	35%	38%
,, 1926	1·03	1·25	·56	·67	·11	·125	5·8	6·5	·45	·57	·61	·83	32½/85	38/85	36%	46%
,, 1925	·93	1·12	·44	·53	·11	·12	4·7	5·4	·39	·51	·57	·68	38/95	40/95	46%	33%
,, 1924	1·03	1·17	·56	·66	·135	·145	5·3	6·5	·44	·53	·59	·66	22½/86	20/86	34%	25%
,, 1923	1·11	1·26	·58	·69	·145	·16	5·4	6·6	·50	·58	·59	·66	26½/83	25/83	18%	14%
,, 1922	1·09	1·33	·66	·82	·135	·16	5·6	6·8	·49	·61	·63	·80	32/81	41/81	29%	31%
,, 1921	1·01	1·19	·51	·66	·13	·15	5·4	6·3	·46	·56	·54	·64	21½/76	25/76	17%	14%

A=Sample taken above the outlet of effluent from the works. **B**=Sample taken below the outlet of effluent from the works

TABLE XVII.—PARTICULARS *RE* COST FOR SEWAGE DISPOSAL OF THE CITY OF MANCHESTER AT THE DAVYHULME WORKS, 1896 to 1929.

Year ending	Maintenance charge		Capital charge		Total outlay on purification works to date	Total capital and maintenance charges		Per cent. purification of raw sewage		Average number of population connected to sewers
	Total per annum	Cost per head of population	Total per annum	Cost per head of population		Total per annum	Cost per head of population	As measured by the 4 hours oxygen absorption test	As measured by the albuminoid ammonia test	
	£	Pence	£	Pence	£	£	Pence	Per cent.	Per cent.	
December, 1896	15,780	10·4	8,129	5·4	162,572	23,909	15·8	.. ...	.....	363,040
,, 1897	19,089	9·9	9,797	5·1	195,942	28,886	15·0	.....	.....	462,020
,, 1898	20,000	9·3	10,517	4·9	210,334	30,517	14·2	.....	.....	515,120
March, 1900	18,728	8·1	10,634	4·6	212,672	29,362	12·7	.....	.....	553,910
,, 1901	21,439	9·2	10,793	4·6	215,866	32,232	13·8	39	38	558,812
,, 1902	19,212	8·2	12,395	5·3	247,893	31,607	13·5	40	40	564,200
,, 1903	15,512	6·6	17,473	7·4	349,457	32,985	14·0	38	41	567,570
,, 1904	14,684	6·1	21,316	8·7	426,323	36,000	15·0	45	52	574,130
,, 1905	14,273	6·0	23,506	9·8	470,121	37,779	15·8	68	71	575,270
,, 1906	18,648	7·8	24,069	10·0	481,374	42,717	17·8	70	74	575,900
,, 1907	21,795	9·1	24,029	10·0	480,566	45,824	19·1	64	69	576,620
,, 1908	27,147	11·3	24,730	10·3	494,614	51,877	21·6	61	68	577,230
,, 1909	30,457	12·4	25,982	10·6	519,643	56,439	23·0	64	70	588,600
,, 1910	27,674	11·0	27,239	10·8	544,785	54,913	21·8	67	72	603,910
,, 1911	22,660	8·9	28,444	11·2	568,884	51,104	20·1	69	70	611,100
,, 1912	24,530	9·8	29,569	11·8	591,376	54,099	21·6	74	76	602,000*
,, 1913	28,730	11·4	29,928	11·9	598,567	58,658	23·3	74	76	605,000
,, 1914	31,634	12·3	30,540	11·9	610,794	62,174	24·2	77	78	616,000
,, 1915 (53 weeks)	32,347	11·4	30,832	10·8	616,637	63,179	22·2	71	71	682,000
,, 1916	30,871	9·8	30,857	9·8	617,149	61,728	19·6	71	72	755,000
,, 1917	26,818	8·5	31,121	9·9	622,425	57,939	18·4	68	71	755,000
,, 1918	30,798	9·6	31,121	9·7	622,425	61,919	19·3	62	63	768,000
,, 1919	34,954	11·0	31,121	9·8	622,425	66,075	20·8	58	61	764,000
,, 1920 (53 weeks)	61,805	19·4	31,683	9·9	633,676	93,488	29·3	54	60	765,000
,, 1921	92,595	28·8	31,840	9·9	636,805	124,435	38·7	51	55	770,500
,, 1922 ..	97,298	31·5	32,088	10·3	641,764	129,386	41·9	54	59	741,600*
,, 1923	73,759	23·7	32,278	10·4	645,568	106,037	34·1	62	63	747,100
,, 1924	68,382	21·9	32,278	10·4	645,568	100,660	32·3	63	65	748,300
,, 1925	52,771	16·9	32,278	10·3	645,568	85,049	27·2	53	57	750,500
,, 1926 (53 weeks)	57,269	18·2	32,278	10·3	645,568	89,547	28·5	54	56	754,000
1927	57,442	18·2	33,322	10·6	666,443	90,764	28·8	49	51	757,000
,, 1928	58,984	18·6	35,582	11·2	711,645	94,566	29·8	45	45	760,200
,, 1929	59,679	18·8	37,324	11·7	746,481	97,003	30·5	46	48	763,500

Note.—The capital charges given above include the cost of all land purchases at Davyhulme and Flixton.

The annual charges have been computed by taking 5 per cent. of the total outlay to date.

* The estimation of the population connected to the sewers was revised in the light of the latest census returns.

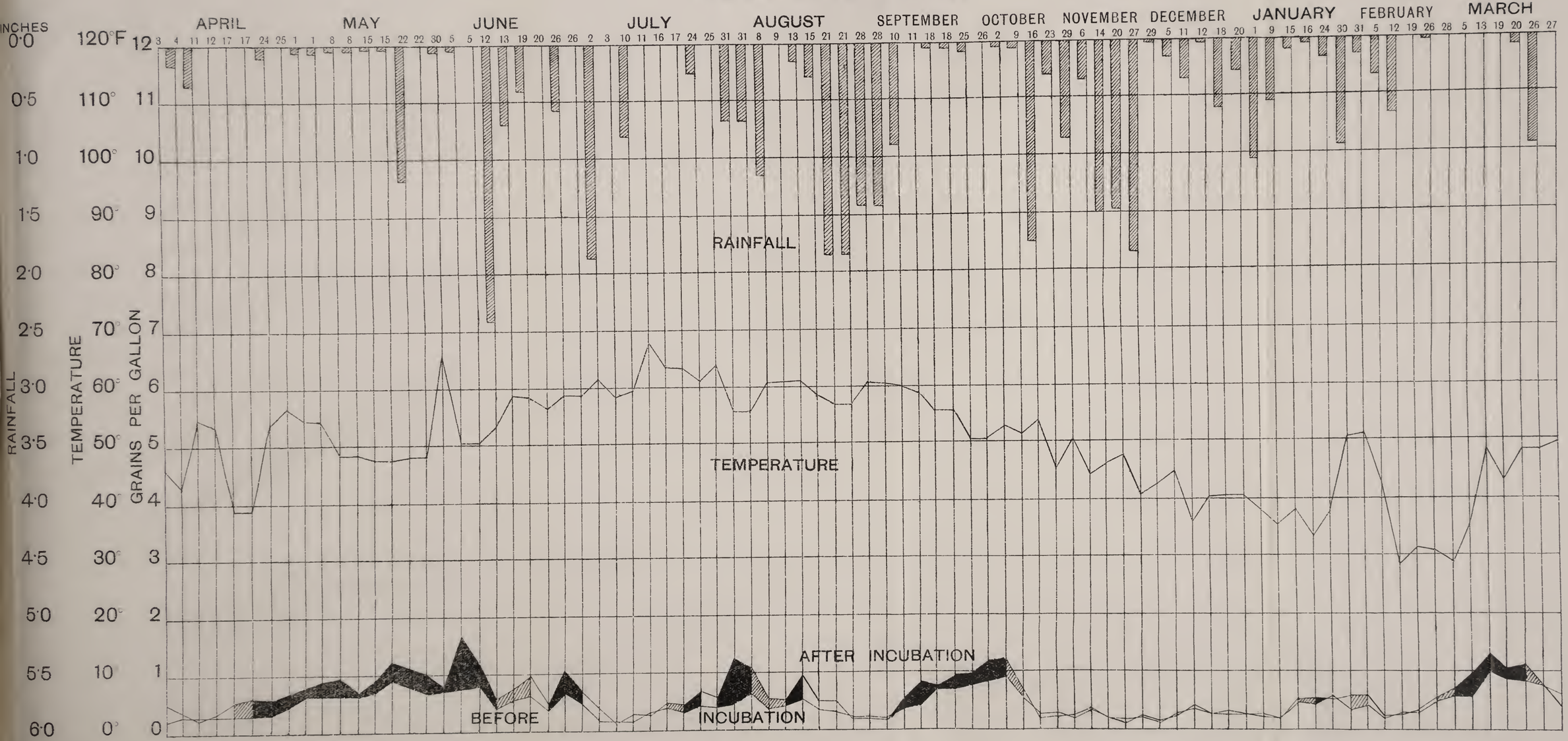
SHIP CANAL WATER ABOVE WORKS OUTFALL.

DIAGRAM 1.

1928 — 1929

INCUBATOR TEST.

3 MINUTES OXYGEN ABSORPTION.

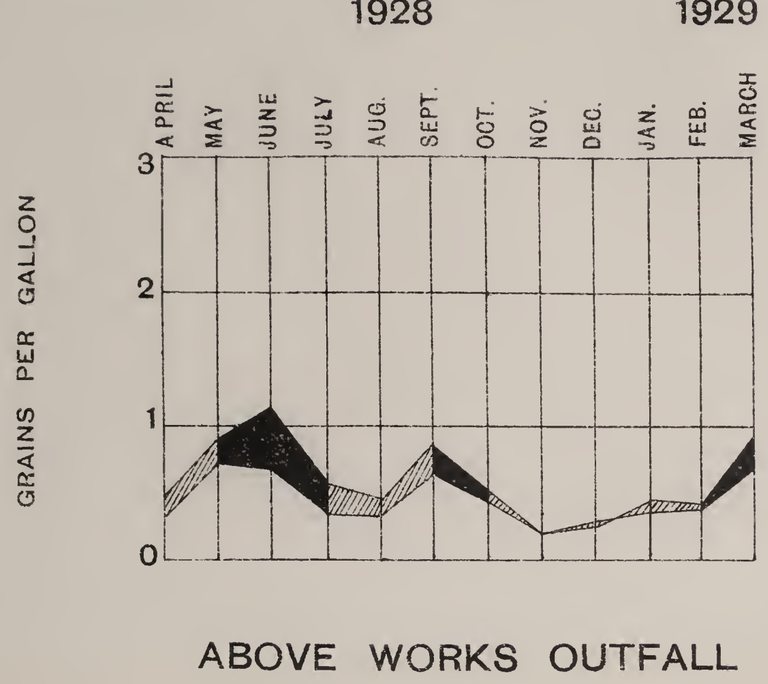



TEMPERATURE
GRAINS PER GALLON
BELOW
ABOVE
WATER
CANAL
SHIP

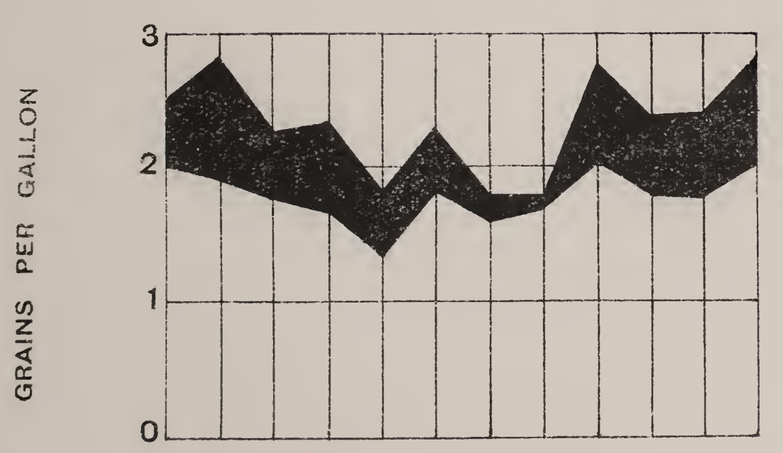
MONTHLY AVERAGES OF ANALYSES OF SHIP CANAL WATER TAKEN ABOVE AND BELOW WORKS OUTFALL, AND AVERAGE EFFLUENT FROM WORKS.

DIAGRAM 2.

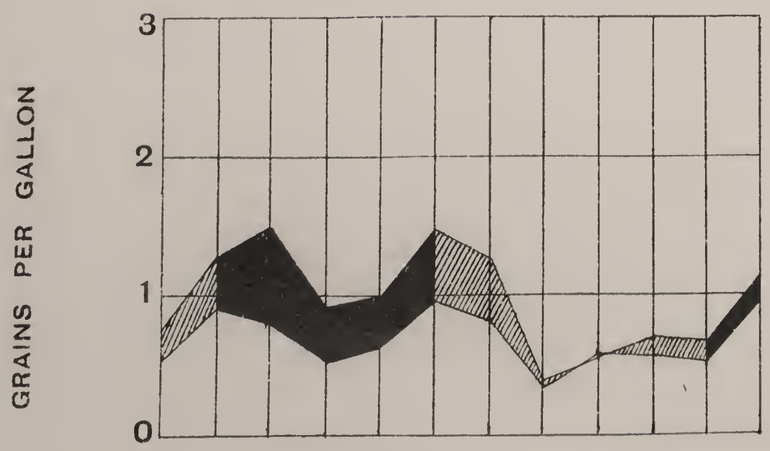
INCUBATOR TEST. **3 MINUTES OXYGEN ABSORPTION.**



ABOVE WORKS OUTFALL

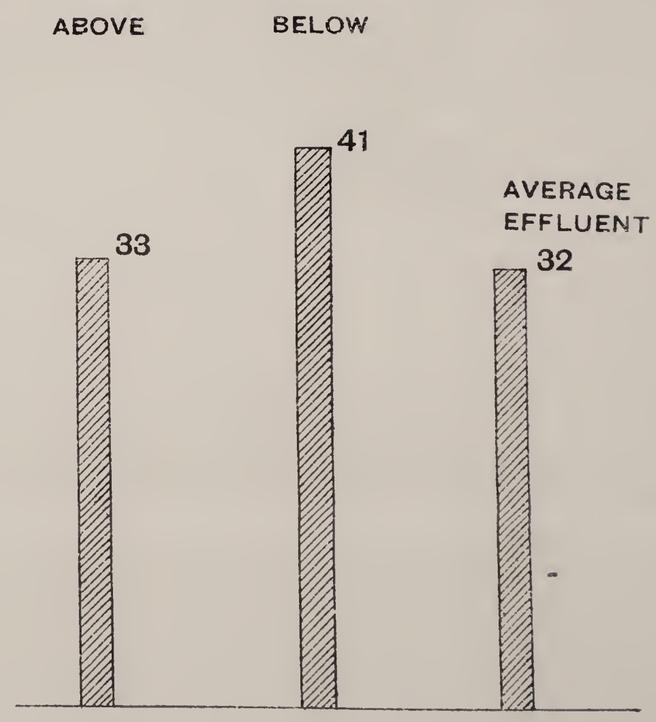


AVERAGE EFFLUENT



BELOW WORKS OUTFALL

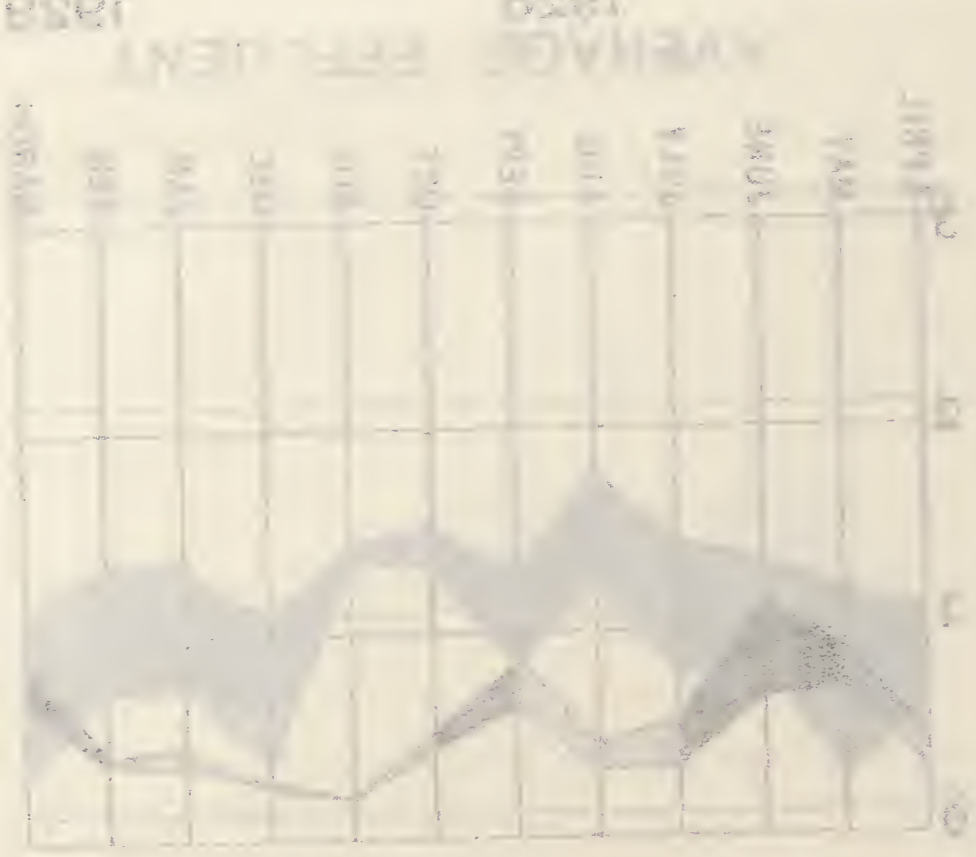
AVERAGE PER CENT. INCREASE AFTER INCUBATION



MONTHLY AVERAGES OF ANALYSES OF SHIP CANAL WATER
TAKEN ABOVE AND BELOW WORKS OUTFALL AND
AVERAGE EFFLUENT FROM WORKS.

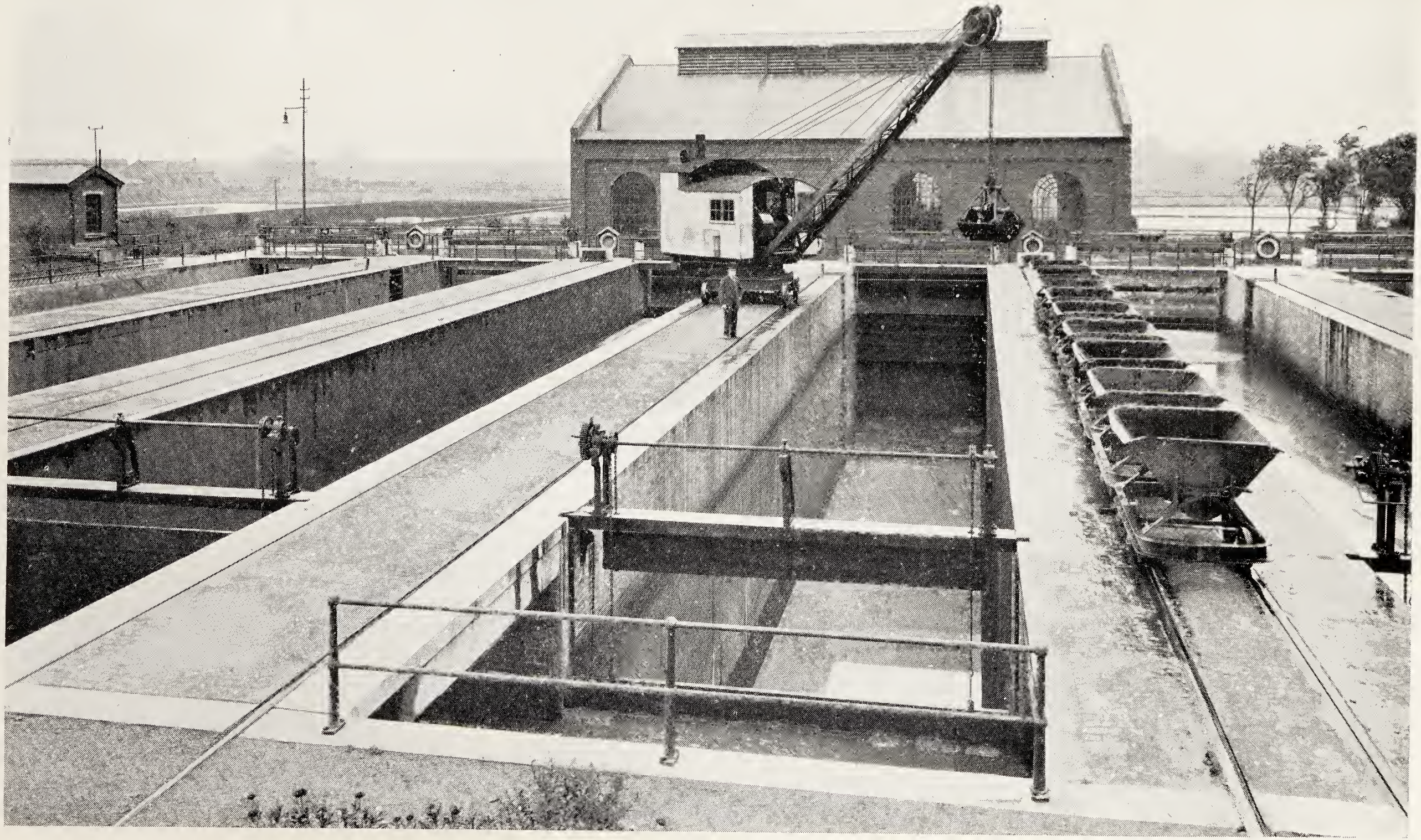
DIAGRAM

INCUBATION TEST. 3 MINUTES OXYGEN ABSORPTION.



Photograph No. 1.

DAVYHULME SEWAGE WORKS: NEW DETRITUS TANKS.



Photograph No. 2. DETRITUS TANKS AND SCREENING CHAMBER: DAVYHULME SEWAGE WORKS.

Photograph No. 3.

OUTLET FROM DETRITUS TANKS AND INLET TO SCREENING CHAMBER:
DAVYHULME SEWAGE WORKS.

Photograph No. 4. TRAVELLING ROPE BAND SCREENS AT THE DAVYHULME SEWAGE WORKS.